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A REVISION OF THE NEARCTIC SPECIES OF THE GENUS ONTHOPHILUS LEACH (COLEOPTERA: HISTERIDAE)

by

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ABSTRACT

The Nearctic species of the histerid genus Onthophilus Leach are revised. Fourteen species are recognized, of which six are described as new: O. deflectus, O. intermixtus, O. wenzeli, O. cynomysi, O. thomomysi and O. giganteus.

All species are described and illustrated with scanning electron microscope pictures. Drawings were made of male genitalia for species in which males are known, of mouth parts for alternatus, and of the hind wing for alternatus and flohri. A key and diagnoses are provided for separating species. The distributions of species are indicated on maps. A brief discussion of the distribution, ecology and taxonomic affinities and evolution is included.

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INTRODUCTION

Onthophilus Leach is a small genus of the family Histeridae. The strong sculpturing of its dorsal surface makes this a readily identifiable genus, but because it is rarely encountered by general collectors, Onthophilus is never represented by many specimens in most collections. The Palearctic species of Onthophilus were revised most recently by Reichardt in 1933. The Nearctic species have not been revised since Horn's revision of 1873, in which he recognized four species. Since then, four more species have been described and substantially more new material has been accumulated.

This study offers a taxonomic treatment of Nearctic Onthophilus Leach, and consolidates existing information. Fourteen species are recognized. Six are described as new, and previously named species are redefined. An artificial key and diagnostic characters are provided for identifying the species. Brief discussions are included on the distribution, on what is known about the habits of the species, and on the taxonomic affinities of the species.

HISTORICAL REVIEW

Leach erected the genus Onthophilus in 1817 to accommodate two previously described species, Hister striatus Forst. and H. sulcatus Fab. Leach provided a key, based mainly on antennal characters, to separate this genus from others that were extant at that time, but he did not include a description. The genus was better defined by Leconte in 1845, on the basis of three North American species, alternatus Say, nodatus Leconte and pluricostatus Leconte. A more complete description is found in Marseul's Monograph of 1856. Both Leconte's and Marseul's concept of the genus Onthophilus was broad enough to include three species, hispidus Paykull, costipennis Fahrs., and novemcostatus Marseul. These species differ from the other species of Onthophilus in several marked ways. They are covered dorsally by dense setae or scales which often obscure the elytral sculpture, the prosternum is bicarinate, and they have a pronounced fovea in the front angles of the metasternum. Thirty-two names were proposed before 1891. At that time, Lewis erected the genus *Epiechinus* to accommodate seven hispid species of *Onthophilus*. Reichardt's concept of the genus in 1933, comprises those species which were left in *Onthophilus* after Lewis erected *Epiechinus*, and is followed here.

The first Nearctic species to be placed in *Onthophilus* was *alternatus*, described by Say in 1825 from the Melsheimer collection. Leconte (1845) in his revision of the North American Histeridae, added *nodatus* and *pluricostatus*. In addition to these three species, Horn recognized a new species from California, in 1870; in his 1873 revision of the North American species of Histeridae. Horn considered *nodatus* and *pluricostatus* as varieties of *alternatus*. Subsequently various catalogues, for example Bickhardt (1910), have treated the Say and the Leconte species as synonyms, although Lewis (1905) and Reichardt (1933) retained their specific status. They are recognized as valid species in the present paper and types are designated for them. Lewis described two species from Mexico, *flohri* and *julii*, in 1888 and in 1892 respectively. In 1893, Casey described a species from Colorado and named it in honour of the collector H. Soltau. Ross (1944b) named a species *kirni* from Texas in honour of A. J. Kirn with whom he was collecting arthropods associated with *Geomys*. The numerous species added since 1856, make Marseul's key inadequate for identifying Nearctic material.

The higher classification of the Histeridae is very unclear and is in need of much work. *Onthophilus* was previously placed close to *Abreus* in the subfamily Abreinae, for reasons which are difficult to explain. Wenzel (1944) moved *Onthophilus* to the subfamily Tribalinae, but this genus and other closely related genera, *Peploglyptus*, *Glymma*, *Stictostix* and *Epiechinus*, can not be placed satisfactorily until a revision of the Histeromorphae is completed.

DISTRIBUTION

At present a total of thirty species of *Onthophilus* Leach have been described. There are thirteen species, one subspecies and one variety recognized from the Palearctic region. Seven of these are extant in Siberia, China, Formosa and Japan, and six in western Europe, the Near East and northern Africa. All these species are confined to either the eastern or the western part of the region. Two species are recognized from Burma. One was collected from 7000'; no data are provided with the other description. One species, *australis*, was collected by H. F. Howden in Australia. This is the first record of *Onthophilus* in that continent.

Fourteen species are recognized from the Nearctic region. Two species, *deflectus* and *pluricostatus*, range from Michigan and New York in the north, south along the Appalachians and the Mississippi valley to the Gulf states. *Onthophilus alternatus* and *nodatus* are found in the coastal lowlands of the southeastern states; *nodatus* has been recorded as far west as eastern Texas; *giganteus* is known only from Archer, Florida. Five species occur in the central states, each recorded from only one locality -- *soltaui* from Denver, Colorado; *cynomysi* from Grady Co, Oklahoma; *kirni* from Somerset, Texas; *wenzeli* from Nebraska and *intermixtus* from Graham Co., Arizona. One species, *lecontei*, has been collected along the coast of California, from San Francisco to San Diego. Three species are from Mexico; *thomomysi* from Durango and also Eagle, New Mexico; *flohri* from Durango; and *julii* from Mexico and Oaxaca. All three species occur above 8000' in Mexico.

From the distribution patterns noted above, it is evident that *Onthophilus* is largely confined to temperate climates. Even those species that occur farthest south, in Mexico and Burma, are confined to high elevations.

ECOLOGY

Virtually nothing is known about the biology of *Onthophilus*. The only source of biological data available is collecting records. Collecting records, however, provide no information that would indicate whether these are the usual habitats in which the species occur, or whether they are only occasional visitors to these habitats.

Adult beetles of most Nearctic species of *Onthophilus* have been collected in traps baited with malt, carrion or dung. *O. pluricostatus* has been found under a dog carcass. *O. deflectus* has been recorded from detritus in tree holes and between tree buttresses, from forest leaf litter, from dead Polypore, from mouse nests, from chicken decay, from under a pig carcass and from cow dung. *O. kirni*, *cynomysi* and *thomomysi* are recorded from prairie dog burrows. *O. lecontei* has been found in gopher burrows, in a *Vespula pennsylvanica* nest, and on dandelion.

Most species of histerids are thought to be predators of fly larvae and of other small arthropods, although there are very few literature references that confirm this generalization by direct observation. The structure of the mouth parts of *Onthophilus* suggests that the species are predators. It is not unlikely, therefore to assume that the adults of this genus, are general predators of fly larvae or of other small arthropods in leaf litter, in dung, in carrion and in the nest and fecal chambers of some rodents and other small mammals. It is their secretive habits and the relatively specialized techniques required to collect them, that undoubtedly account for the poor representation of the various species of *Onthophilus* in most collections.

No records or biological observations of the larval stages of *Onthophilus* exist. Because dung and carrion disappear very rapidly in the summer, it is likely that the larvae will be found in some more stable niche, such as rodent burrows in the case of some species, or in leaf litter in others. The larvae of a few other histerid genera are known to be predators on the eggs and larvae of small arthropods. *Onthophilus* larvae will probably conform to this predatory trend in the Histeridae.

TAXONOMIC AFFINITIES AND EVOLUTION

The family Histeridae is evidently an old one. *Onthophilus* and the genera related to it, represent an unusual and divergent branch of this family. One fossil species, *O. intermedius* Handschin (1944) establishes that this genus dates from at least the Oligocene. It may be assumed that in the past this genus had a much more continuous distribution. The present distribution of the species indicates a progressive series of radiations and of subsequent fragmentations.

The species now extant in the Nearctic region are apparently polyphyletic in origin. Those ten species for which males are known can be placed into three groups on the basis of the structure of the male genitalia. These groups may be conveniently referred to by the name of the oldest named species within that group. The composition of the groups is as follows:

(1) *lecontei* group: *lecontei*, *cynomysi*, *thomomysi* and *kirni*
(2) *alternatus* group: *alternatus*, *nodatus* and *pluricostatus*
(3) *flohri* group: *flohri*, *deflectus* and *intermixtus*

The median lobe of the male aedeagus of the *lecontei* group, is extruded ventrally between the bifid apex of the parameres. The median lobe of the *alternatus* group and the *flohri* group, is extruded dorsally. The *flohri* group differs from the *alternatus* group in the form of the basal piece. The basal piece of the *alternatus* group is long and tubular. The basal piece of the *flohri* group is short and ovoid. The basal opening is rotated sinistrally 45 degrees from the longitudinal midline and is subapical. These groups share external characteristics within groups, which allows the placement, with some confidence, of *wenzeli* and *soltaui* into the *lecontei* group. The only species which cannot be placed with any confidence is *julii*. No other species of *Onthophilus*, anywhere, has such greatly interrupted elytral costae. The only other species which approaches *julii* in this characteristic, is *tuberculatus* from Burma. The general outline, punctation and so forth, of *julii* suggests that it is closer to the *flohri* group than to either of the other two Nearctic groups.

All three Nearctic groups have close taxonomic affinities to species in the eastern and/or western Palearctic region, but the exact phylogenetic relationships are obscure. For example, the head and thorax of *silvae* from Japan resemble those of *alternatus* very much, but its elytral costae are equally well developed. Similarly, the pronotum of *wenzeli* resembles that found in the *alternatus* group, but in the rest of its characters, it is very close to the other species of the *lecontei* group.

The general east-west division of the Nearctic species, is probably an expression of the Tertiary orogeny and the subsequent development of the recent xerophytic vegetation (Axelrod, 1958). Apparently the species of the *lecontei* group have survived the xeric conditions by utilizing the more amenable conditions found in mammal burrows and similar habitats. It is not clear, whether this is a primitive adaptation of the group, or whether these species invaded these niches and speciated within them after the onset of xeric conditions. Certainly this mode of behaviour is not confined to the *lecontei* group, but is found in other species of *Onthophilus*, in the Nearctic and the Palearctic regions (Bedwell, 1907), and in other genera of both the Histerinae and Saprininae.

A more recent distribution pattern that is the result of the Pleistocene glacial cycles is superimposed on the older one. *O. deflectus* and *flohri* are two morphologically very similar species. The former is found in eastern United States and the latter in Mexico. This distribution pattern suggests that these species arose from an ancestral population by prolonged isolation during a glacial cycle. Interestingly, this species separation is accompanied by a reduction of the inner wings of *flohri*. The specimens of *flohri* that I have seen are from the western edge of the Sierra Madre Occidental at high elevations. Very likely, suitable habitats are sparsely and irregularly distributed in this area and are subjected to strong prevailing winds from the ocean. Under these circumstances the reduction and the consequent loss of flight would have high survival value and would be selected for in order to minimize the loss of individuals. Whether this is also true for other populations of this species, is difficult to say, until further collecting reveals the complete range of this species. Pleistocene isolation is expressed in other species by pockets of variability within their range. For example, specimens of nodatus from eastern Texas have larger punctures than specimens from the eastern portion of its range. Possibly these specimens represent a population which was separated from the main body of the species during the last glacial period.

METHODS

This study was based on an examination of approximately 500 museum specimens of Onthophilus.

Cleaning: Most specimens of Onthophilus are heavily covered by a waxy exudate to which soil particles and other detritus have adhered. This accretion forms a hard coating which obscures many important taxonomic characters. Many different compounds were tested in attempts to clean specimens. The most successful of these was a 10 % (w/v) solution of sodium phosphate, tribasic (TSP, Na_3PO_4). This solution softened the waxy exudate sufficiently that it could be peeled away with a camel hair brush. In addition this solution relaxes specimens very efficiently.

Dissection Techniques: Male genitalia were extracted through the pygidium of specimens relaxed in hot water or TSP. The genitalia were cleared in a hot 10 % solution (w/v) of potassium hydroxide, prior to the separation of the terminalia and the aedeagus. For further study and illustration, microscope slides were prepared using a glycerin gel medium . Mouth parts, wings and other structures were handled in a similar manner, except that the mouth parts were stained with a 10 % solution of basic fuchsin in 95% ethyl alcohol.

Illustrations: A net reticule was used to make all the measurements and as an aid in making the drawings. The length was measured from the tip of the front angles to the hind margin of the elytra. The width was measured at the widest point. At least one specimen of each species was photographed uncoated, using a JEOL JSM-U3 scanning electron microscope. Magnifications did not exceed 100X.

Terminology: Striae and other surface features are important characters for defining and identifying species of Histeridae. For the terminology of the sclerites and striae, I have followed the useage of Wenzel and Dybas (1941). The following is a definition of the abbreviations used in the text for important costae and carinae that have no prior names.

Head (Fig. 21)

VFC	verto-frontal carina, is located along the longitudinal midline reaching from the occipital carina to between the antennae; may be variously reduced.
LFC	latero-frontal carina runs from the antennal pit, obliquely across the face to, or just above the clypeus.

Pronotum (Figs. 42, 43, 44)

These costae are bilaterally symmetrical.

PC 1	pronotal costa one is the costa closest to the lateral edge.
PC 2	pronotal costa two is the costa immediately mesad of PC 1.
PC 3	pronotal costa three is the costa closest to the longitudinal midline.

Elytron (Figs. 42, 43, 44)

There are eight striae on the elytron of Onthophilus. Beginning from the suture and going towards the lateral margin these are as follows: the closest to the suture is the sutural stria; lying to the outside of this are striae five to one, stria five being the closest to the sutural stria; then the internal subhumeral stria; and on the inflexed lateral area of the elytron is a sinuous external subhumeral stria. The striae give their names to the major elytral costae that lie immediately mesad of them. The minor carinae between the striae and costae are not named. The strial numbering in the Histeridae is opposite to that found in most other beetles. This convention is followed because the striae closest to the suture are more frequently obsolete than the striae farthest from the suture.

SC	sutural costa lies mesad of the sutural stria, between it and the suture.
EC 5	elytral costa five, lies mesad of stria five.
EC 4	elytral costa four lies mesad of stria four.
EC 3	elytral costa three lies mesad of stria three.
EC 2	elytral costa two lies mesad of stria two.
EC 1	elytral costa one lies mesad of stria one.
ISC	internal subhumeral costa lies mesad of the internal subhumeral stria.
ESC	external subhumeral costa lies mesad of the external subhumeral stria, and because it is straight and not sinuous it is separated from the stria at its front end by a semicircular area.
Pygidium (Fig. 35)	
TC	transverse carina runs across the pygidium in the front half; it may be nearly straight or W-shaped.
LC	longitudinal carina runs along the longitudinal midline; it may be variously reduced.
Propygidium (Fig. 35)	
PMC	carina that runs along the longitudinal midline; if present usually tear-shaped.
PLC	carina that runs along the lateral margin.

TAXONOMY

Onthophilus Leach[1]

Onthophilus Leach 1817: 78; Leconte 1845: 50; Marseul 1856: 549; Horn 1873: 138.

TYPE SPECIES. *Hister sulcatus* F. designated by Westwood 1840: 22. (*Onthophilus* misspelled *Orthophilus* on pg. 22, corrected on pg. 157.)

The generic characters which are diagnostic for *Onthophilus* are the following: the prosternal lobe is present but narrow; the antennal scape is not expanded or strongly angulate; the labrum has at least two setiferous punctures; the antennal cavities are in the anterior prothoracic angles and partly covered by the prosternal lobe; the pronotum has two to six costae; the elytron has eight striae and eight costae and appears strongly sculptured; the prosternum is without striae; the metasternum is without pronounced fovea; setae if present on the dorsal and ventral surface are very short and not prominent.

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[1] Only literature dealing with Nearctic species at the revisional level is cited. For literature dealing with Palearctic species refer to Bickhardt 1910: 79.

This combination of characters (based in part on Wenzel, 1962) serves to distinguish Onthophilus from other genera in the family Histeridae and in the subfamily Tribalinae.

The Nearctic species of Onthophilus are dark brown to reddish brown and are under 6.0 mm in length. Their shape is oval and they are moderately convex transversely and longitudinally.

The head is deflexed. The antennae are inserted in front of the eyes, are eleven segmented, the last three are fused into an oval club with the sutures indistinct, and are hidden under the thorax in fossae that are in the anterior angles of the prothorax and are partly covered by lateral extensions of the prosternal lobe. The mouth parts are illustrated in Figs. 1-3.

Pronotum has two or six costae. The marginal and lateral striae of the pronotum are obsolete. Elytron has eight striae with strong punctures and eight strong costae. External subhumeral stria sinuous and subcariniform. Area between this stria and lateral margin of elytron with irregular punctures. Scutellum small and triangular. Propygidium and pygidium strongly deflexed, with or without carinae.

Prosternum without striae. Hind margin emarginate. Mesosternum short, front margin lobed to fit prosternal emargination. Metasternum without fovea. Meso and metaepisterna with large contiguous punctures. Clearly defined by sutures. Legs are short and retractile; femora slightly swollen with minute, elongate punctures; protibia expanded apically and spinulose; meso- and metatibia narrow with few rows of spines, tibial spurs unequal and distinct; tarsi 5-5-5, short with simple claws.

Male aedeagus is surrounded by terminalia composed of the sclerites of the eighth, ninth and tenth abdominal segments. The tegmen is composed of a tubular or ovoid basal piece that is free moving and articulated to the parameres. The parameres are fused for most of their length, forming a tube that surrounds the penis and median lobe; their apex is bifid and strongly curved. The penis is flat, its apex is curved and surrounds the median lobe; its basal end is formed into two apodemes. The median lobe is extruded dorsally or ventrally between the bifid apex of the parameres. Female genitalia with hemisternite narrow and articulated to stylus; no sclerotized spermatheca was observed. The terms follow usage by Lindroth and Palmen (1956) and the male and female genitalia are illustrated in Figs. 7-19.

ARTIFICIAL KEY TO THE NEARCTIC SPECIES OF ONTHOPHILUS LEACH

1. Length from front angles of pronotum to hind margin of elytra greater than 4 mm. . . . . . . 14. giganteus n. sp. (p. 30)
Length from front angles of pronotum to hind margin of elytra less than 4 mm. 2

2. Elytral costae one to five interrupted at least three times, consequently costae are reduced to series of elongate tubercles (fig. 38). . . . . 1. julii Lewis (p. 10)
Elytral costae one to five entire or costa one or three interrupted no more than once. 3

3. Elytral costae two and four much more strongly developed than costae one, three and five (figs. 40, 42). 10

Elytral costae one to five equally, or very nearly equally, strongly developed (figs. 41, 45). 4

4. Pronotum with costae two and three absent, or very faintly indicated by weakly raised, shining areas (figs. 49, 50). 5
Pronotum with costae two and three clearly indicated and entire (figs. 45, 46, 47, 48). 6

5. Elytral costa three interrupted before the front margin by a short, deep, transverse fossa (fig. 50). Metasternum with shallow, fine punctures on the central area (fig. 63). . . . . 13. kirni Ross (p. 29)
Elytral costa three entire to the front margin, without short, deep, transverse fossa. Metasternum with deep, medium sized punctures along front and hind margins; two large, triangular, discal areas with only minute punctures (fig. 62). . . . . 12. thomomysi n. sp. (p. 27)

6. Median longitudinal carina of pygidium strong. Pronotal punctures elongate on discal area; interstices arranged in a strigose pattern (fig. 41). . . . . 4. intermixtus n. sp. (p. 15)
Median longitudinal carina of pygidium absent. Pronotal punctures round or oval on discal area; interstices not arranged in a strigose pattern. 7

7. Second pronotal costa strong and complete from front to hind margin (fig. 45). Mesosternum with two rows of punctures only in the middle (fig. 58). . . . . 8. wenzeli n. sp. (p. 22)
Second pronotal costa clear but abbreviated before front and hind margin; the ends sometimes covered with punctures that are nearly as large as those in the intercostal areas (figs. 46, 47, 48). Mesosternum with at least two complete rows of punctures across it. 8

8. Second pronotal costae convergent behind; these costae higher and broader at the hind ends (fig. 46). Metasternum rather densely punctate; without two distinct, triangular discal areas that are punctulate (fig. 59). . . . . 9. cynomysi n. sp. (p. 23)
Second pronotal costae parallel or divergent behind; these costae not distinctly higher and broader in the hind half. Metasternum with two distinct, triangular discal areas that are punctulate; punctures along front and hind margin large, dish-like, sometimes with smaller, deep punctures inside their leading edge (figs. 60, 61). 9

9. Lateral edge of pronotum smoothly arcuate or weakly angulate, never parallel in hind 0.5 (fig. 48). First abdominal sternum with large punctures along front

margin and a distinct, semi-circular median area that is punctulate (fig. 61). . . . . 11. lecontei Horn (p. 26)

Lateral edge of pronotum strongly angulate at midpoint, sides parallel in hind 0.5 (fig. 47). First abdominal sternum rather densely punctate; punctures becoming gradually smaller from front to back (fig. 60). . . . . 10. soltaui Casey (p. 25)

10. Metasternum with a common or two triangular discal areas that are smooth or minutely punctured; punctures elsewhere small or large and dish-like with a small, deep puncture inside the leading edge (figs. 55, 56, 57). 11

Metasternum coarsely, rather uniformly punctate throughout; punctures large and shallow, without small punctures inside their leading edge (figs. 52, 53). 13

11. Metasternum with a strongly impressed, longitudinal, broad channel; triangular, minutely punctured discal areas elevated and irregularly oval (fig. 57). . . . . 7. pluricostatus Leconte (p. 20)

Metasternum without strongly impressed, longitudinal, broad channel; triangular, minutely punctured discal areas fused or not elevated (figs. 55, 56). 12

12. Metasternum with no coarse punctures along the longitudinal midline, or with punctures along the longitudinal midline and on the front 0.3 that are not significantly larger than the punctures on the prosternum and that are separated by two to three times their diameters (fig. 55). . . . . 5. alternatus (Say) (p. 16)

Metasternum with coarse, crateriform punctures with small deep punctures inside their leading edge, along the longitudinal midline and on the front 0.3 (fig. 56). . . . . 6. nodatus Leconte (p. 18)

13. Lateral edges of pronotum straight and strongly convergent towards the front, and not reflexed in hind 0.5 (fig. 39). . . . . 2. deflectus n. sp. (p. 12)

Lateral edges of pronotum arcuate or feebly angulate at midpoints, and distinctly reflexed in hind 0.5 (fig. 40). . . . . 3. flohri Lewis (p. 14)

1. Onthophilus julii Lewis

Figures 20, 31, 38, 51, Map 2

Onthophilus julii Lewis, 1892: 124. TYPE. Holotype, female, from Mexico: Amecameca. Sacromonte, X.1891, collected by Julius Flohr from under decaying plants, alt. 8,300 ft (BMNH, London), not seen.

DIAGNOSIS. This species is readily distinguished from all other New World species of Onthophilus by the greatly interrupted elytral costae.

Elytral costae one, three and five are low and interrupted five times. Elytral costae two and four and the internal subhumeral costa are much higher and are interrupted three times. The general outline of the body and the punctation, especially on the meso and metasternum, suggest that this species is most closely allied to *flohri*, *deflectus* and *intermixtus*.

FEMALES. Length: 2.4 mm; width: 2.0 mm. Black with brassy tinge on head, pronotum and elytra. *Head* with VFC strong and complete. LFC strong and curved inward; carinae meeting above clypeus, forming a short single carina. Punctures on vertex, frons and genae large, round to irregular, and contiguous; on clypeus and vertices of LFC much smaller. Labrum with setiferous punctures in lateral 0.2; front margin straight. *Pronotum* transverse. Lateral margin broadly, obtusely angulate, somewhat rounded; lateral bead weak but distinct; surface along lateral edge reflexed. Disk 6-costate. PC 1 strong, very short and slightly curved inward. PC 2 strong, reaching from front 0.3 to just before the hind margin and curved gently outward. PC 3 strong; reaching from front margin to hind 0.1, but may be completely interrupted in the middle third of its length; curved slightly outward. Punctures large, round to irregular, contiguous, except smaller along hind margin; vertices of elevations with double row of minute punctures. Surface between PC 1 and PC 2 strongly concave, forming a broad trench that curves to the front angle; trench deepest just behind front angle. *Elytron* wider than pronotum. EC 1, EC 3 and EC 5 much lower than EC 2, EC 4 and ISC; interrupted five times; elongate tubercles more prominent in hind 0.3. EC 2, EC 4 and ISC very prominent; interrupted three times; tubercles behind front margin longest. ESC low and interrupted only once in the middle. SC very much attenuated in front 0.3. All costae with two rows of irregular punctures along their base; punctures prominent between tubercles. Interspaces between costae with clear stria that is bordered by two low carinae; strial punctures small and round, deepest at front margin, with two small lateral tubercles that interrupt the low carinae. Surface depressed behind front margin, forming shallow, transverse trench in front of costae. *Propygidium* with PMC strong; slightly abbreviated in front and behind. PLC strong, about 0.3 times as long as PMC. Punctures large, shallow, irregular and contiguous; on vertices of elevations very fine. *Pygidium* with LC strong, bifurcating in the middle of the pygidium, arms reaching hind 0.2. TC strong and straight; intersecting LC in front 0.2. Surface depressed before and behind TC. Punctures similar to those on the propygidium, except smaller and more pronounced on outer margins. *Prosternum* slightly concave between procoxae, convex before. Hind margin broadly, roundly emarginate. Punctures coarse, irregular, shallow and contiguous; about 0.5 times as large and more rounded on prosternal lobe. *Mesosternum* short and transverse. Front margin lobed to fit prosternal emargination. Punctures similar to those on the prosternum. *Metasternum* separated from mesosternum by a suture which is irregular due to the punctures encroaching on it. Median longitudinal suture fine and obscured in part by punctures. Surface slightly depressed behind the front margin and along the median longitudinal suture; elevated triangular area between meso- and metacoxae. Punctures intermixed large and small, irregular and contiguous, except small on triangular area. *First abdominal sternum* punctate throughout; punctures similar to those on prosternum. Surface strongly reflexed behind front margin. *Protibia* slightly expanded distad, with eight short spicules each on a weakly elevated base.

MALE. Unknown.

SPECIMENS. Mexico. Oaxaca. km 154 on Route 175 south of Oaxaca, 8,000 ft, 2-3.VI.1971, H.F. Howden, 1 female. 20 km n. Oaxaca, 9,500 ft, 7.VI.1971, S. Peck, under carrion, 1 female.

REMARKS. I have seen only two specimens of this species, both females. The variation between these two specimens from Oaxaca is very slight. In specimen collected south of Oaxaca both PC 3 carinae are completely obsolete in the middle 0.3, but no other significant differences were detected. P.M. Hammond kindly compared my specimens with the holotype, which is a little smaller and the elytral costae are not quite so raised.

2. Onthophilus deflectus new species

Figures 11, 39, 52, Map 1

Onthophilus deflectus n. sp. TYPE. Holotype, male, Trelease Woods, Urbana, Ill., 28.IV.1951, R.K. Benjamin, (FMNH, Chicago), collected on dead Polypore. Allotype, female, with the same data as the type, (FMNH, Chicago). Paratypes, all material listed in the section on specimens examined.

DIAGNOSIS. The densely punctate meso- and metasternum separates this species from other species, with the exception of flohri, in which the major elytral costae are unequally developed. This species may be distinguished from flohri, which it resembles closely, by the following characters. The lateral pronotal edges of deflectus are nearly straight and strongly convergent in the hind 0.5; the front angles of the pronotum are broadly round; and the meso- and metasternum are convex. The lateral pronotal edges of flohri are arcuate or weakly, broadly angulate and subparallel in the hind 0.5; the front angles of the pronotum are not broadly round; the meso- and metasternum are concave in the males and flat or weakly concave in the females. In its general outline and punctation deflectus also resembles intermixtus but may be separated from the latter by the almost equally well developed elytral costae, smoothly arcuate lateral edge of the pronotum, and the long pronotal costa one, of intermixtus.

MALES. Length: 1.8 to 2.0 mm; width: 1.6 to 1.8 mm. Head with VFC strong. LFC strong and meeting just above clypeus. Punctures on frons, vertex and genae large, roundish, deep and contiguous; punctures much smaller on clypeus and on the vertices of elevations. Labrum with setiferous punctures in lateral 0.2. Pronotum 0.5 times as long as wide. Lateral margins nearly straight in hind 0.5 and strongly convergent frontwards; lateral bead poorly developed; hind angles not reflexed, surface smoothly concave to lateral edges; front angles broadly rounded. Disk 6-costate. PC 1 short and straight; reaching from just before the hind margin to front 0.5. PC 2 long and straight; reaching from the hind margin to just before the front margin. PC 3 long and straight; reaching from the front margin to hind 0.1. Surface not deeply concave between PC 1 and PC 2. Punctures between PC 1 and lateral edge and along hind margin large, round, and contiguous; punctures between costae large, elongate and contiguous, with interspaces arranged in strigose pattern; punctures on vertices of elevations minute and sparse. Elytron wider than pronotum. EC 1, EC 3, EC 5 and ESC much lower in the front 0.75 than EC 2, EC 4 and ISC. ISC, EC 2, EC 4 and SC with a clear row of large quadrate punctures along their bases. EC 1 and EC 3 abbreviated before front margin. SC strongly attenuated in front 0.2. Vertices of costae with two rows of minute punctures. Spaces between costae with strong stria bordered by two low carinae; strial punctures strong, oval and deep with small but clear tubercles on their lateral edges that interrupt the low carinae. Surface with slight transverse depression near the middle running from ISC to EC 3. Propygidium with PMC strong; reaching from front 0.3 to hind 0.1. PLC short, reduced to round tubercle. Punctures large, irregular deep and contiguous. Vertices of elevations with minute punctures. Pygidium with LC strong; reaching from front margin to hind 0.1. TC strong, obtuse V-shaped, meeting LC in front 0.3. Punctures similar tothose on the propygidium. Prosternum flat between procoxae, convex in front. Hind margin broadly, roundly, shallowly emarginate. Punctures round, large and small intermixed, and contiguous; unctures smaller on prosternal lobe. Mesosternum short and transverse. Front margin lobed to fit the prosternal emargination. Punctures similar to those on the prosternum. Metasternum separated from the mesosternum by a fine suture. Median longitudinal suture distinct. Surface with a broad, oval discal elevation between meso- and metasternum. Punctures round to irregular, larger than on mesosternum and contiguous; punctures slightly smaller on elevations, with minute punctures on interstices. First abdominal sternum punctate throughout; punctures similar to those on prosternum. Protibia with 12-14 small spicules on only slightly elevated bases. Male genitalia shown in fig. 11.

FEMALES. Length: 1.9 to 2.2 mm; width: 1.6 to 2.0 mm. Very similar to males. They can usually be distinguished from males by the metasternum, which is in females only very slightly depressed along the longitudinal median suture.

SPECIMENS. CANADA: ONTARIO. Essex Co., Lasalle, 19-20.V. 1967, K. Stephan, 1 male, 3 females. UNITED STATES: ALABAMA. Jackson Co., Scottsboro, 4-8.IV.1967, S. Peck, forest litter, 1 female. ILLINOIS. Cook Co., Joliet, 18.IV.1927, O. Park, cow dung, 1. Urbana, Trelease Woods, 17.III.1944, W.E. Snow, ex tree hole, 1 female; 28.IV. 1951, R.K. Benjamin, from dead Polypore, 1 male, 3 females. INDIANA. Porter Co., 1 mi. S.W. of McCool, 4.X.1952, H.S. Dybas, 1 female, berlese leaf litter. MARYLAND. Takoma Pk., 16.V.1943, E.S. Ross, 2 males. MICHIGAN. Berrien Co., Lakeside, Warren Woods, 25.VI.1966, W. Suter, buttress debris beech, 1 male. MISSISSIPPI. Meridian, 8.II., H. Soltau, 1. MISSOURI. Boonville, 4.V.1964, G.G. Kennon, ex mouse nest under split oak log, 1 male, 1 female. NEBRASKA. F.C. Bowditch, 1. NORTH CAROLINA. Black Mts., VI.1902, Van Dyke, 1. Round Knob, 25. VI., Hubbard and Schwartz, 17. SOUTH CAROLINA. Clemson, 28.II.1962, J.A. Payne, chicken decay, 1; 27.I.1967, J.A. Payne, dead pig remains, 6. TENNESSEE. Blount Co., Great Smoky Mts. Nat. Pk., Cedar Cove, 8.VI. 1960, W. Suter and J. Wagner, alt. 1700 ft, leaf litter, 1. Specimens are in the following collections: Cal. Acad., San Francisco; FMNH, Chicago; USNM, Washington; Howden, Ottawa.

REMARKS. This species is named deflectus because unlike any other species, the lateral edge of the pronotum is not reflexed in the hind 0.5. The hind angles of the pronotum appear to bend down.

Most of the specimens of this species that I have seen are quite uniform in appearance, except those from Black Mountain and Round Knob, North Carolina and the specimen from Nebraska. The PC 3 costae of these specimens may be weakly to strongly, or not at all attenuated at their mid-points, and the EC 2 costa is weakly to rather strongly attenuated in the front 0.3. The strial puncture in stria 3 at this point is sometimes strong and reinforces the appearance that there is a transverse fossa across the elytron in the front 0.3. There is a spectrum of variability from specimens in which only the EC

2 is slightly attenuated to specimens in which the PC 3 is virtually interrupted and the EC 2 is strongly attenuated. No differences were noted in the male genitalia of the specimens. At this time, I would like only to note that this variability exists. Further studies and collecting will determine whether these forms should receive formal recognition as subspecies or whether they should be elevated to specific status.

3. Onthophilus flohri Lewis

Figures 6, 9, 12, 21, 32, 40, 53, Map 2

Onthophilus flohri Lewis, 1888: 235. TYPE. Holotype, sex unknown, labelled "type", Mexico. Durango. 8.VIII.1887, J. Flohr, (BMNH, London), not seen.

DIAGNOSIS. O. flohri resembles deflectus and intermixtus in general outline and the densely punctate meso- and metasternum. Characters that are useful for separating flohri from the former, are discussed in the diagnosis for deflectus. Intermixtus has almost equally well developed elytral costae and the pronotal costa one is long. In flohri, elytral costae one, three and five are much lower than elytra costae two and four, and the pronotal costa one is short. This species is readily distinguished from other species with unequally well developed elytral costae by the densely punctate meso- and metasternum.

MALES. Length: 2.0 to 2.5 mm; width: 1.6 to 1.8 mm. Head with VFC strong, reaching occipital carina. LFC strong above antennal pit, becoming obsolete above clypeus; curved inward slightly. Punctures large, shallow, irregular, and confluent on frons and genae; smaller and elongate above antennal pit; interstices arranged in strigose pattern; smaller and rounded along front margin of clypeus; vertices of elevations with small, round punctures. Labrum with setiferous punctures in lateral 0.2; front margin arcuate. Pronotum transverse, 0.50 as long as wide. Lateral margin arcuate, or weakly angulate at mid-point; slightly reflexed. Front margin slightly emarginate; front angles obtuse. Disk 6-costate. PC 1 short, straight; reaching from front 0.5, hind 0.10 or 0.05. PC 2 curved inward; abbreviated only slightly in front and behind. PC 3 straight; abbreviated behind, reaching from front margin to hind 0.20. PC 2 and PC 3 convergent towards the front. The two PC 3 almost parallel. Punctures at edges small and round; between costae elongate, interstices arranged in strigose pattern. Elytron wider than pronotum. ESC, ISC, EC 2, EC 4, and SC abruptly elevated and prominent; EC 1, EC 3 and EC 5 much lower and abbreviated just behind front margin. All costae abbreviated just before hind margin. SC attenuated in front 0.3; EC 1 slightly attenuated in the middle. All costae with a row of minute punctures on each side just below the vertex; EC 2, EC 4, SC and ISC with two basal rows of large quadrate punctures along each side. Spaces between costae with a strong stria bordered on each side by a low carina; strial punctures oval and deep, deepest in front, with a clear tubercle on each side that interrupts the carinae. Propygidium with front margin reflexed. PMC strong; reaching from just behind front margin to hind 0.2 to 0.1. PLC 0.5 times as long as PMC. Punctures large, round and separated by 0.5 times their diameters; vertices of elevations with minute punctures. Pygidium with LC strong; reaching from front margin to hind 0.4 to 0.3. TC strong, obtuse V-shaped, meeting TC in front 0.35. Punctures similar to those on propygidium. Prosternum with distinct depression between procoxae. Hind margin obtusely, roundly emarginate; somewhat sinuous. Punctures large, round, separated by their diameters; much smaller punctures between larger punctures, more dense towards the lateral margin. Prosternal lobe with punctures much smaller. Emargination present between prosternal lobe and proepisternum. Mesosternum short and transverse. Front margin lobed to fit prosternal emargination. Punctures smaller and sparser than those on prosternum. Metasternum separated from mesosternum by an indistinct suture. Median longitudinal suture very fine and indistinct. Surface strongly depressed in the central area. Punctures large, round, separated by their diameters; punctures on discal area and along midline 0.50 times as large. First abdominal sternum punctate throughout with punctures similar to those on metasternum, but becoming smaller towards the hind margin. Protibia with eight weak spicules each on a slightly elevated base. Male genitalia illustrated in fig. 12.

FEMALES. Length: 2.6 to 2.8 mm; width: 1.6 to 2.1 mm. The females are very similar to the males. The metasternum of females is flat or only weakly depressed.

SPECIMENS. MEXICO: Durango. El Salto, 5.VI.1937, E.S. Ross, 44, (Cal. Acad.); 10 mi. W. El Salto, 16.VI.-12.VII.1964, H.F. Howden, 317, (CNC, Howden); 11-15.VII.1964, 9000 ft, J.E.H. Martin, 18, (CNC); 1.VII.1964, Linquist, oak, fir duff, dung, 7 (CNC); 11 mi. W. El Salto, 14-17.VI.1964, S. Peck, dung and carrion, 27, (CNC).

REMARKS. This species is at present known only from El Salto, Durango and has been collected in great numbers in baited traps. The variability expressed is quite low. The PC 1 costa of the males is slightly variable in length, and some males are slightly, but noticeably, smaller than most. The hind wing of at least the females is very much reduced. P.M. Hammond has kindly compared some of my specimens with the type.

4. Onthophilus intermixtus new species

Figures 14, 41, 54, Map 4

Onthophilus intermixtus n. sp. TYPE. Holotype, male, ARIZ. Graham Co. Pinaleno Mts. Wet Cn. 6100 ft, 29.VII.1969, A. Smetana, (CNC, Ottawa). Paratype, 1 male with the same data as the holotype (Howden, Ottawa).

DIAGNOSIS. This species resembles most closely flohri and deflectus in its general outline and punctation. It may be distinguished from them most readily by the almost equally well developed elytral costae. Other characters that are useful in separating these species are included under the specific description of deflectus. Although intermixtus has almost equally well developed elytral costae, it differs from those species in which the elytral costae are equally well developed in many significant ways. The dense, round to irregular punctation of the meso- and metasternum will immediately separate it from those species. The elytra are more convex, more elongate and the elytral costae are narrower and more sharply elevated than in the other two species.

MALES. Length: 2.5 mm; width: 1.8 mm. Head with VFC strong and complete. LFC strong, sharply elevated and meeting above clypeus. Punctures on vertex large and irregular, yielding strigose pattern; on frons and genae large, round to irregular, shallow and contiguous; on vertices of elevations small to minute. Labrum with front margin weakly arcuate; setiferous puncture in lateral 0.2; very short setae interspersed irregularly in front 0.5, separated by 3.0 to 5.0 times their length. Pronotum 0.5 times as long as wide. Lateral margin smoothly arcuate; lateral bead strongly developed; surface along lateral edge reflexed from hind angles to front margin. Disk 6-costate. PC 1 long, straight and well developed; reaching from front 0.25 to hind margin. PC 2 strong, curved inward in front 0.25, straight in hind 0.75; reaching from just before front margin to hind margin. PC 3 strong and straight; reaching from front margin to just before hind margin. Surface smoothly convex between costae. Punctures large, round and shallow between lateral edge and PC 1; elongate, with interstices arranged in strigose pattern between costae, becoming sparser towards the middle; small to minute on vertices of elevations. Elytron wider than pronotum. EC 3, EC 5 and SC slightly lower than other costae in front 0.3. All costae with two rows of minute punctures just below the vertex; short yellow setae arising from them in the hind 0.5. All costae with a row of small quadrate punctures, which form a fine stria along the base, cutting off a fine and irregular carina. EC 3 slightly attenuated just before the front margin. Spaces between costae with a strong stria between two low carinae; strial punctures strong, oval and deep, with clear tubercles on their lateral edge, that interrupt the low carinae. Propygidium with PMC strong; reaching from front 0.1 to hind 0.1. PLC strong, 0.3 times as long as PMC. Punctures large, deep, irregular and contiguous; smaller on vertices of PLC. Pygidium with LC strong, complete from front to hind margin. TC very obtuse V-shaped, indistinct with punctures encroaching on its course, meeting LC in front 0.25. Punctures similar to those on propygidium, except smaller on two indistinct lateral tubercles and much smaller on vertex of LC. Prosternum flat between procoxae, convex in front. Hind margin broadly, roundly, shallowly emarginate. Punctures large, round, deep and separated by 0.5 times their diameters, with much smaller punctures on the interstices; punctures smaller on prosternal lobe. Mesosternum short and transverse. Front margin lobed to fit prosternal emargination. Punctures similar to those on prosternum, but slightly smaller. Metasternum separated from mesosternum by a fine suture. Median longitudinal suture fine and distinct; surface weakly concave along it. Punctures intermingled large and medium sized, round, deep and nearly contiguous, with small punctures on interstices; small punctures dense on small oval area behind mesocoxa. First abdominal sternum with punctures along the front margin similar to those on metasternum, becoming progressively smaller towards the hind margin. Protibia with six small spicules on elevated bases in apical 0.5. Male genitalia illustrated in fig. 14.

FEMALE. Unknown.

SPECIMENS. This species is known only from the type material.

REMARKS. This species is named intermixtus because it apparently shares characters with both the flohri group and the lecontei group. It resembles flohri in most respects but the elytral costae of intermixtus are equally well developed and in this character it resembles the lecontei group.

5. Onthophilus alternatus (Say)

Figures 1, 2, 3, 4, 5, 7, 8, 10, 22, 33, 42, 55, 64, Map 3

Hister alternatus Say, 1825: 46. TYPE. Neotype here designated, female, bearing the following labels -- "orange", "O. alternatus (Say) Er.", red "MCZ TYPE 32249", red "NEOTYPE Helava '75". (Say stated that this species belonged in the genus Onthophilus Leach.)

Onthophilus alternatus (Say) Leconte, 1845: 52. Marseul, 1856: 558. Horn, 1873: 303.

DIAGNOSIS. *O. alternatus* is very similar to *nodatus* and *pluricostatus* in its general outline, in the shape and disposition of its pronotal costae and in the sculpture of its elytra. This species is most readily distinguished from the latter two species by the sparse punctation of the metasternum and by the shape of the punctures. Male specimens of *alternatus* have no large punctures along the longitudinal midline, only very fine punctures; females have few large punctures along the midline and have two large oval-triangular discal areas that are punctulate. The metasternal punctures on the central area are not ocellate in *alternatus*, but rather small and deep, with an abrupt leading edge and a less abrupt and fan-like trailing edge. If the ventral surface is not visible, *alternatus* may be distinguished with some confidence by the bituberculate verto-frontal carina and the fine, deep punctation of the pygidium.

MALES. Length: 1.6 to 1.9 mm; width: 1.4 to 1.7 mm. *Head* with VFC bituberculate. LFC strong, curved inwards; the two LFC meeting above the clypeus. Punctures on frons and genae small, deep and round; separated by 3.0 to 4.0 times their diameters; punctures much smaller, shallower and denser on vertices of elevations and above antennal sockets. Labrum with setiferous punctures in lateral 0.25. *Pronotum* 0.55 times as long as wide. Lateral margin feebly angulate at midpoint; lateral edge reflexed; lateral bead not prominent. Disk 6-costate. PC 1 slightly sinuous, strong; complete from front 0.3 to hind margin. PC 2 subsinuous, strong; complete from front margin to just before hind margin. PC 3 straight, strong; complete from front margin to hind 0.2. Surface much higher between inner four costae, than between PC 2 and lateral margin. Punctures, except on costae, small, deep, slightly elongate and separated by their diameters; punctures on vertices of elevations minute. *Elytron* wider than pronotum. ESC, ISC, EC 2, and EC 4 much higher and more pronounced than EC 1, EC 3, EC 5 and SC. EC 1 interrupted in front 0.3; EC 3 interrupted before front margin by a short transverse fossa between stria three and stria four; SC attenuated just behind the scutellum. Spaces between costae with a strong stria bordered on each side by a low carina; strial punctures deep and oval, especially deep just behind the front margin and in the front 0.3 of stria one to stria four, these giving the effect of a transverse depression; strial punctures with a tubercle on each side that interrupts the carina. All costae with a row of minute punctures on each side below the vertex. *Propygidium* with front margin strongly reflexed. PMC strong, complete from front 0.2 to hind 0.1. PLC 0.5 times as long as PMC. Punctures small, deep, round and separated by 2.0 to 3.0 times their diameters; punctures on vertices of elevations minute. *Pygidium* with front margin slightly reflexed. LC obsolete except in hind 0.2 or 0.1. TC strong and shaped like two contiguous shallow U's. Punctures similar to those on propygidium. *Prosternum* slightly depressed or flat between procoxae. Hind margin broadly, roundly emarginate. Punctures small, deep, round and separated by 2.0 to 3.0 times their diameters; prosternal lobe and interstices of punctures punctulate. *Mesosternum* short and transverse. Front margin lobed to fit prosternal emargination. Punctured like prosternum. *Metasternum* separated from mesosternum by a fine, indistinct suture. Median longitudinal suture a fine, distinct, impressed line. Surface slightly to rather strongly depressed in front 0.5. Punctures along front margin small, deep and round, spaced irregularly; punctures along hind margin and on lateral areas large, irregular and sometimes indistinct, shallow and dish-like, with small, deep, round punctures near the leading edge. Central areas and interstices of punctures punctulate.

First abdominal sternum with front margin reflexed. A single row of punctures along front margin that are like those on the hind area of metasternum; punctures dense and much smaller on lateral areas; punctulate on central area. *Protibia* with seven to eight spicules, each on a weakly elevated base. *Male genitalia* illustrated in fig. 10 .

FEMALES. Length: 2.0 to 2.5 mm; width: 1.6 to 2.0 mm. The females are very similar to males, except that the metasternum is not depressed and there is a double row of punctures along the longitudinal midline, leaving two large oval-triangular, punctulate, discal areas. The pygidial carina LC is longer; it is obsolete except in the hind 0.4 or 0.5.

SPECIMENS. UNITED STATES: ALABAMA. Seale, 21.III.1954, H.F. Howden, 9. FLORIDA. Clarksville, 21.III.1954, H.F. Howden, 20. DeFuniak Spr., 21.III.1954, H.F. Howden, 5. Levy Co., P. Laurent, 1. Mossy Head, 21.III.1954, H.F. Howden, ex skunk dung, 1 female. LOUISIANA. 10 mi. S.W. Alexandria, 1.IV.1960, J.G. Chillcott, 1 male, 4 females. NORTH CAROLINA. Raleigh, 18.X.1952, H. & A. Howden, ex *Rhizopogon piceus*, 25. Southern Pines, 6.X.1949, H. & A. Howden, ex rotten watermelon rind, 14. SOUTH CAROLINA. Columbia, 3.III.1932, O.L. Cartwright, 1. Windsor, XI.1933, E.S. Ross, ex dung, 31. Specimens are in the following collections: Cal. Acad., San Francisco; USNM, Washington; FMNH, Chicago; Howden, Ottawa; CNC, Ottawa; AMNH, New York; MCZ, Cambridge; ANSP, Philadelphia.

REMARKS. There is not a great deal of variability between the specimens examined. The pygidial carina LC is somewhat variable in length, both in males and females. Also the metasternal punctation is reduced in some males; the punctures are smaller and more irregular, often fused together behind the mesocoxae.

Say described *alternatus* from the Melsheimer collection under the name *Hister alternatus*, but stated that this species belonged to the genus *Onthophilus* Leach. It is very difficult to determine from Say's description to which species this description corresponds, and unfortunately Say's types, if extant in the Melsheimer collection, were not labelled. Leconte redescribed *alternatus* in 1845, but did not provide any useful diagnostic characters to separate *alternatus* from *nodatus* and *pluricostatus* which he described at the same time. However, Leconte did send a Zimmerman specimen from Georgia to Marseul, who redescribed *alternatus* in 1856. In the key to the species of *Onthophilus*, Marseul described the metasternum as "imponctué et impressioné au milieu" and in the description he stated that the metasternum is "fovéolé au milieu finement pointillé et entouré de quelque gros points épars". For these reasons, I have decided to attach the name *alternatus* to the species in which the males have no large punctures along the longitudinal midline, and in which the females have two large oval-triangular, punctulate discal areas. Although the distribution of this species appears to be centered in the southeastern states, and it may be unlikely that Say had a specimen which corresponds to my useage, I have decided to follow the useage of Leconte and Marseul, and have chosen a Leconte specimen as neotype.

6. *Onthophilus nodatus* Leconte

Figures 16, 23, 34, 43, 56, Map 2

Onthophilus nodatus Leconte, 1845: 53. TYPE. Holotype, (MNHN, Paris) not seen. Marseul, 1856: 556. Horn, 1873: 303.

DIAGNOSIS. *O. nodatus* is very nearly allied with *alternatus* and *pluricostatus*. This species may be separated from the former by the characters given in the diagnosis for *alternatus*. *O. nodatus* may be distinguished from *pluricostatus* by the following characters. The metasternum of *pluricostatus* is strongly depressed along the longitudinal midline, forming a broad, rounded trench from the front to the hind margin. This trench is stronger in the males than in females. The metasternum of *nodatus* is not depressed along the midline, although the large crateriform punctures along the midline sometimes give that impression. The tubercles on each side of the strial punctures are much stronger and clearer in *nodatus*, especially in striae three, four and five, than the tubercles in *pluricostatus*. The pronotal costae three of *nodatus* are, in general, parallel in the front 0.5 and are closer to each other than to pronotal costae two. The pronotal costae three of *pluricostatus* are divergent in the front 0.5 and are closer to pronotal costae two than to each other. The lateral margin of the pronotum of *nodatus* is more strongly reflexed than that of *pluricostatus*.

MALES. Length: 2.3 to 2.6 mm; width: 1.8 to 2.3 mm. *Head* with VFC strong and entire, reaching from occipital carina to frons between antennae. LFC strong, the two convergent, meeting above clypeus forming a short single carina. Punctures large, round, deep and separated by their diameters; interspaces of large punctures and vertices of elevations with minute punctures. Labrum with small, shallow punctures; setiferous punctures in lateral 0.25. *Pronotum* transverse, 0.5 times as long as wide. Lateral margins angulate in middle and very strongly reflexed; lateral bead prominent. Front margin weakly emarginate; front angles obtuse; front margin strongly reflexed from front angles to PC 2. Disk 6-costate. PC 1 long, straight or curved inwards; reaching from front 0.25 to hind margin. PC 2 subsinuate; reaching from front margin to just before hind margin. PC 3 curved feebly outward; reaching from front margin to slightly before hind margin. Surface between the four median costae higher than between PC 2 and lateral margin. Punctures medium, oval or round and deep; separated by their diameters. *Elytron* wider than pronotum. ESC, ISC, EC 2, EC 4, and SC abrupt and more strongly developed than EC 1, EC 3, and EC 5. EC 1 interrupted in front 0.3-0.5; EC 3 interrupted before front margin by a short transverse fossa between stria three and four, and interrupted in front 0.5; SC attenuated in front 0.2. All costae with a row of minute punctures on each side just below vertex. Spaces between costae with a strong stria bordered on each side by a low carina; strial punctures large, oval and deep; strial punctures strongest just behind front margin and in the front third of stria one to stria four; strial punctures with very strong tubercles on each side that interrupt the low carinae. EC 1, EC 2 and EC 3 attenuated before hind margin. *Propygidium* with front margin strongly beaded and reflexed. PMC strong; reaching from front 0.2 to hind 0.2. PLC slightly shorter than PMC. Punctures large, round and deep; separated by their diameters; vertices of elevations with minute punctures. *Pygidium* as long as wide. LC briefly interrupted behind transverse carina. TC bisinuate; with two short branches extending backwards in lateral 0.25 that are sometimes joined to LC. Punctures like those on propygidium. *Prosternum* flat between procoxae, strongly convex and higher in front. Hind margin broadly, roundly emarginate. Punctures large, round and deep; separated by their diameters; prosternal lobe with small, round, deep punctures. *Mesosternum* transverse, short. Front margin lobed to fit prosternal emargination. Punctures large, round and deep and contiguous. *Metasternum* separated from mesosternum by a fine suture. Median longitudinal suture fine. Surface flat or slightly depressed. Punctures on narrow, triangular discal area minute, round and shallow; punctures elsewhere very large, shallow dish-like depressions with large, deep, round punctures within. First abdominal sternum with a row of large punctures like those on the hind margin of the metasternum, behind the front margin, becoming smaller and denser on the lateral areas; central area punctulate. Protibia with seven to eight spicules, the two most distad on weakly elevated bases. Male genitalia illustrated in Fig. 16.

FEMALES. Length: 2.6 to 3.0 mm; width: 2.3 to 2.5 mm. The females are very similar to males. The metasternum is slightly convex and the metasternal punctures are generally larger and are denser along the midline.

SPECIMENS. UNITED STATES: ALABAMA. 17 mi. N. Abbeville, 22.III.1954, H.F. Howden, ex malt trap, 1. FLORIDA. 2 mi. W. Archer, 24.III.1953, Howden & Dozier, ex propionic acid trap, 1. St. Augustine, 3. GEORGIA. 10 mi. N. Ft. Valley, Rt. 341, 17.III.1956, Howden & Howell, ex malt, 3. Tifon, 6.X.1968, J.A. Payne, ex gopher tortoise dung trap outside burrow, 1. NORTH CAROLINA. Southern Pines, 9.II.1952, H. & A. Howden, 1. OKLAHOMA. Payne Co., 20.III.1926, W.J. Brown, 1. SOUTH CAROLINA. Florence, 18.II.1938, 2. TEXAS. Nacogdoches, 14.V.1974, V. Nealis, ex human dung trap, pine-oak, 4. Specimens are in the following collections: FMNH, Chicago; USNM, Washington; CNC, Ottawa; Howden, Ottawa; MCZ, Cambridge.

REMARKS. There is very little variability between the specimens examined of this species, other than that already noted. Marseul's description of this species in 1856 corresponds closely to the specimens labelled O. nodatus in the Leconte Collection.

7. Onthophilus pluricostatus Leconte

Figures 13, 24, 35, 44, 57, Map 5

Onthophilus pluricostatus Leconte, 1845: 51. TYPE. Lectotype, here designated, sex not determined, bearing the following labels -- "orange", "937", "O. pluricostatus", red "MCZ TYPE 32251", red "lectotype Helava '75". Marseul, 1856: 565. Horn, 1873: 303.

DIAGNOSIS. This species is very closely allied with alternatus and nodatus. O. pluricostatus may be distinguished from these species by the broad, rounded, trench-like depression along the longitudinal midline of the metasternum. Further characters that separate this species from the latter two are dealt with under the diagnoses for alternatus and nodatus.

MALES. Length: 2.3 to 2.5 mm; width: 1.7 to 2.1 mm. Head with VFC entire. LFC strong, meeting above clypeus, and forming a short, single carina. Punctures large, round and deep; separated by their diameters on frons, genae and vertex; smaller above antennae; vertices of elevations with minute punctures. Labrum with small, shallow and round punctures; setiferous punctures in lateral 0.25. Pronotum 0.5 times as long as wide. Lateral margin strongly angulate at mid-point, sides in hind 0.5 parallel and convergent in front 0.5; lateral edges strongly reflexed; lateral bead indistinct. Front margin reflexed from front angles to PC 2; front angles 90°. Disk 6-costate. PC 1 strong, slightly curved outwards; complete from front 0.25-0.3 to hind margin. PC 2 sinuous; complete from front to hind margin. PC 3 straight, slightly curved outward in hind 0.1; complete from front margin to just before hind margin. Surface of pronotum elevated between four median costae. Punctures medium, round and deep, separated by their diameters; sparser and slightly elongate between the PC 3; denser and slightly larger along lateral margin. *Elytron* wider in front than pronotum. ESC, ISC, EC 2, EC 4 and SC more abrupt and higher than EC 1, EC 3 and EC 5. EC 1 weakly attenuated in front 0.35 to 0.5; EC 3 interrupted before front margin by a short, transverse fossa between stria three and four; SC attenuated behind front margin. All costae with a row of very minute punctures on each side just below the vertex. All costae weakly attenuated before hind margin. Spaces between costae with a strong stria bordered on each side by a low carina; strial punctures large, oval and deep, deepest just behind front margin, and with small tubercles on each side; tubercles clearest in stria one and two, and interrupt the low carinae. *Propygidium* with front margin smoothly arcuate and strongly reflexed. PMC strong and complete from front 0.2 to 0.25 to hind 0.1. PLC 0.5 times as long as PMC. Punctures medium, round and deep; separated by their diameters. *Pygidium* with front margin slightly reflexed. TC very obtuse V-shaped. LC complete from front to hind margin except sometimes briefly interrupted just behind TC. Punctures similar to those on propygidium. *Prosternum* flat between procoxae, convex in front. Hind margin roundly, quite deeply emarginate. Punctures medium, round, deep and separated by 1.0 to 2.0 times their diameters; punctures on prosternal lobe much smaller. *Mesosternum* short and transverse. Front margin lobed to fit prosternal emargination. Punctures much larger than those on prosternum; dish-like with medium, round and deep punctures in their centers, and nearly contiguous. *Metasternum* separated from mesosternum by a suture and an irregular impunctate line. Median longitudinal suture fine. Surface with broad, rounded, trench-like, longitudinal depression along the midline from the front to the hind margin. Punctures on two triangular, somewhat oval, weakly elevated discal areas small, round and shallow; punctures in front, behind and on lateral areas large, irregular, dish-like with medium, round, deep punctures inside them, and contiguous; punctures in depression smaller. *First abdominal sternum* with punctures along front margin like those on the lateral areas of the metasternum, except fan-like at their trailing edges; punctures smaller on lateral areas, becoming much smaller and sparser on central area. *Protibia* with eight small spicules, each on a weakly elevated base. *Male genitalia* illustrated in fig. 13 .

FEMALES. Length: 2.3 to 2.7 mm; width: 2.1 to 2.3 mm. The females are very similar to the males in most respects, except that the median depression of the metasternum is not well developed and clear in some specimens. These females may be identified with some confidence by the complete VFC and the carinae of the pygidium.

SPECIMENS. UNITED STATES: ALABAMA. Mobile, 24. Springhill, 24.XI.1918, H.P. Loding, 1. D.C., 1. GEORGIA. 5 mi. W. Toccoa, 3. IX.1967, J.M. & B.A. Campbell, under dog carcass, 5. KENTUCKY. Slade, 25.VIII.1967, J.M. & B.A. Campbell, 1. MARYLAND. Oakland, Hubbard & Schwarz, 1. MASSACHUSETTS. Framingham, 30-31.VII., C.A. Frost, ex fungus, 1. Natick, 13.IX.1913, C.A. Frost, sweeping in woods, 1. Springfield, 1.VIII.1927, D.H. Blake, under *Lactarius*, 1; 1954, Chapin, 1. MICHIGAN. Detroit, Hubbard & Schwarz, 1. NEW JERSEY. Lakehurst, 16.VIII.1912, 1. NEW YORK. Peck, 1. NORTH CAROLINA. Pisgah Forest, Looking Glass Mt., 21, 27.VIII.1940, O.L. Cartwright, 2; Pisgah Forest, 26.VIII.1941, O.L. Cartwright, 16. PENNSYLVANIA. Jefferson Co., 10.IX.1950, O.L. Cartwright, 1. SOUTH CAROLINA. Mountain Rest, 7.IX.1944, O.L. Cartwright, under cow dung, 1. Oconee

Co., Fish Hatchery, 3.IX.1935, 1; CCC Camp F2, 29.VIII.1937, 15.VIII.1947, O.L. Cartwright, 3. Sassafras Mtn, Rocky Bottom, 4.IX.1934, O.L. Cartwright, 1. TENNESSEE. Burrville, 16.X.1954, H.F. Howden, ex malt, 3. Chilhowee Mts., 3.X.1953, H. & A. Howden, ex malt and propionic acid trap, 8. Great Smokey Mt. Nat. Pk., 6.VIII.1955, H. & A. Howden, ex malt, 1. VIRGINIA. Church Falls, 19.VII.1919, E.A. Chapin, ex Lactarius piperans, 1. Lee Co., Jone's Cove, Hubbard & Schwarz, 2. Specimens are in the following collections: FMNH, Chicago; USNM, Washington; CNC, Ottawa; Howden, Ottawa; MCZ, Cambridge; AMNH, New York; O.L. Cartwright.

REMARKS. There is little variability between the specimens examined of this species, other than for the depth and density of punctation of the longitudinal trench of the metasternum. The only specimen in the Leconte Collection identified as O. pluricostatus is not in very good condition, but appears to fit Marseul's description (1856) and that of Leconte (1845), and was therefore chosen as lectotype.

8. Onthophilus wenzeli new species

Figures 25, 45, 58, Map 3

Onthophilus wenzeli n. sp. TYPE. Holotype, female, Nebraska (salt basin), 27.X.1923, Owen Bryant, (USNM, Washington).

DIAGNOSIS. This species may be distinguished from other species with equally well developed elytral costae, by the well developed pronotal costae PC 2 and PC 3, and by the fact that the pronotal costa PC 1 is not strongly and entirely undercut along its inner edge. The pronotal costae of intermixtus are well developed, but it is smaller in size and the meso- and metasternum are densely punctate. The metasternum of wenzeli has two large discal areas that are punctulate.

FEMALES. Length: 3.4 mm; width: 2.4 mm. Head with VFC reduced to a tubercle between antennae. LFC strong at antennae; attenuated in the middle; meeting above clypeus, forming an elevation that reaches the clypeal margin. Punctures round and irregular in size; much finer and denser above antennae and on vertices of elevations. Labrum finely punctate; setiferous punctures in lateral 0.25. Pronotum 0.50 times as long as wide. Lateral margins strongly angulate and reflexed; parallel in hind 0.50, convergent in front 0.50; lateral bead prominent; front angles acute. Disk 6-costate. PC 1 long and straight; reaching from front 0.3 to hind margin. PC 2 subsinuate and entire from front to hind margin. PC 3 slightly curved inward; reaching from front margin to slightly before hind margin. PC 2 and PC 3 closer together than the two PC 3. Surface between PC 1 and PC 2 depressed. Punctures medium size; separated by their diameters; slightly elongate on disk, rounder along lateral bead. Elytron broader than pronotum, narrower behind. All elytral costae equally strong and entire. SC attenuated before front margin. Costae with two rows of minute punctures on vertices. Interspaces between with strong stria bordered by two low carinae; strial punctures strong, more prominent towards front margin. EC 1 slightly attenuated in front 0.30 to 0.45. ESC strongly sinuate; punctate in hind 0.75. Propygidium with PMC strong in hind 0.75. PLC 0.65 times as long; vertex smoothly, broadly rounded. Punctures medium sized and deep along front margin, becoming smaller to minute and sparser towards hind margin and along vertices of elevations. Pygidium with weak, bisinuate TC in front 0.30. Surface depressed between front margin and TC. Punctures medium size, round, separated by their diameters along front margin and on discal area, becoming small to minute along lateral margins and on vertex of TC. *Prosternum* slightly depressed between procoxae. Hind margin deeply, sinuously emarginate. Punctures medium size, round and separated by their diameters, with minute punctures on interspaces and on prosternal lobe. *Mesosternum* short and transverse. Front margin lobed to fit prosternal emargination; strong, bisinuous. *Metasternum* separated from mesosternum by clear suture. Median longitudinal suture faint. Surface depressed along midline in front 0.10. Punctures along midline and front margin dish-like with medium size, round, deep punctures inside front edge; separated by their diameters; behind mesocoxae and lateral areas irregular and confluent; on interspaces and on two large triangular discal areas minute. *First abdominal sternum* with punctures similar to those on front 0.2 of metasternum along front edge and lateral areas; large semicircular median area that is punctulate. *Protibia* with fifteen slender spicules, each on a weakly elevated base.

MALES. Unknown.

SPECIMENS. Known only from the holotype.

REMARKS. The pronotum of this species is very similar to that found in the *alternatus* group. The lateral edge is strongly reflexed and the surface is depressed between PC 1 and PC 2, and the pronotal costae are very strongly developed. At present the range of this species is restricted but further investigations of small mammal burrows will undoubtedly reveal that it has a much wider range. This species is named for R. L. Wenzel in recognition of his assistance to me and other students of the Histeridae.

9. *Onthophilus cynomysi* new species

Figures 15, 26, 37, 46, 59, Map 3

Onthophilus cynomysi n. sp. TYPE. Holotype, male, Oklahoma, Grady Co., 4 mi. N. Blanchard, 17.VIII.1953, M.J. Wilcomb, (FMNH, Chicago). Allotype, female, with the same data as the holotype, (FMNH, Chicago). Paratypes, 5 males and 5 females with the same data as the holotype, (FMNH, Chicago; Howden, Ottawa).

DIAGNOSIS. This species resembles *wenzeli*, *lecontei* and *soltaui* in general outline. All four species have distinct pronotal costae two and pronotal costae three. The pronotal costa one in *cynomysi* is undercut along the entire length of the inner edge, while it is undercut only in the hind 0.2 in *wenzeli*. The pronotal costae two of *cynomysi* are convergent behind while they are straight or divergent behind in the other three species. The strongly and abruptly depressed surface between pronotal costa one and the lateral margin of *cynomysi* serves to separate this species from *lecontei* and *soltaui*.

MALES. Length: 2.5 to 3.1 mm; width: 2.1 to 2.5 mm. *Head* with VFC short, indistinct; often obscured by encroaching punctures. LFC meeting above clypeus; attenuated above clypeus, often indistinct. Surface depressed between the two LFC. Punctures round, medium sized, and separated by 0.5 to 1.0 times their diameters, except finer and setiferous on the vertices of the elevations. Labrum with two setiferous punctures in lateral 0.25, the setae long and prominent; the rest of the surface with much shorter setae that are separated by their lengths. *Pronotum* transverse, 0.5 times as long as wide. Lateral margin broadly angulate at midpoint; lateral bead prominent with inner groove. Front margin shallowly, roundly, emarginate; front angles slightly obtuse. Disk 6-costate. PC 1 slightly subsinuous; reaching from front 0.25 to hind margin; surface along outer edge smoothly, quite abruptly depressed, then abruptly reflexed along lateral margin; inner edge strongly undercut along its entire length; surface between PC 1 and PC 2 depressed, forming a shallow trench that narrows strongly towards the front. PC 2 subsinuous; reaching from front 0.1 to just before hind margin; attenuated in front 0.5, higher and broader behind; obscured in front and behind by punctures. PC 3 curved weakly outward; reaching from just behind front margin to hind 0.25; obscured before and behind by punctures; the two PC 3 convergent behind. Punctures medium sized and separated by their diameters; round to oval on lateral and hind areas, more elongate in trench and on central areas. *Elytron* wider than pronotum. All costae equally well developed. SC slightly attenuated in front 0.3; two confluent and irregular rows of punctures just below the vertex, that are more prominent in hind 0.5. All other costae with two rows of minute punctures that bear short setae in hind 0.5. Interspaces between costae with a strong stria that is bordered by two low carinae; strial punctures much deeper at front margin. *Propygidium* with PMC broad, rounded, strongest just before hind margin; surface depressed behind hind end of PMC. PLC indistinct, broad swelling. Punctures medium size, deep, round and separated by their diameters, except on vertex of median elevation, punctures about 0.5 as large and elongate. *Pygidium* surface without carinae. Front margin reflexed; discal area convex. Punctate throughout; punctures similar to those on propygidium. *Prosternum* generally convex, with slight concavity between procoxae. Hind margin with deep, cuspidal emargination. Punctures round, medium size, deep and separated by 0.5 to 1.0 times their diameters. *Mesosternum* short and transverse. Front margin with a cusp to fit prosternal emargination. Punctures twice as large as those on prosternum, contiguous or separated by 0.5 times their diameters. *Metasternum* separated from mesosternum by clear suture. Median longitudinal suture fine and clear. Median area weakly concave. Punctures along front, hind and lateral margins like those on mesosternum; becoming finer on median discal areas. *First abdominal sternum* with punctures along front margin and on lateral areas similar to those on front third of metasternum; semicircular central area punctulate. *Protibia* with a row of ten to twelve spicules, on elevated bases. *Male genitalia* illustrated in fig. 15.

FEMALES. Length: 3.0 to 3.6 mm; width: 2.5 to 3.0 mm. Except for sexual characters the females differ very little from the males. On the average females are slightly larger than males; the outer edge of the lateral pronotal trench reaches the front 0.3; the metasternum is not depressed along the midline and the protibial spicules are stronger.

SPECIMENS. This species is known only from the type material.

REMARKS. There is very little variability within this species. The facial carina, pronotal costae and the PMC of the propygidium are less distinct in some specimens than in others. The protibial spicules are broken or worn on older specimens.

Virtually nothing is known about the biology or habits of this species. All the material seen was collected by M. J. Wilcomb during his study of prairie dog burrows. The conditioned soil was scraped from the tunnels and small arthropods were extracted with Berlese funnels. The name *cynomysi* does not mean to imply that this species is characteristic of, or confined to *Cynomys* burrows, but merely that this is the niche from which it was taken.

10. *Onthophilus soltaui* Casey

Figures 27, 47, 60, Map 1

Onthophilus soltaui Casey, 1893: 557. TYPE. Holotype, sex undetermined, bearing the following labels -- "Col.", "Denver 10 /1890", "Casey bequest 1925", "soltaui Csy", red "TYPE USNM 38463", (USNM, Washington), not seen.

DIAGNOSIS. This species is very similar to *lecontei* and *cynomysi*. Characters that separate *soltaui* from them are dealt with in the diagnoses for *lecontei* and *cynomysi*.

FEMALES. Length: 3.5 mm; width: 2.5 mm. *Head* with VFC faintly indicated. LFC faint, barely discernable above clypeus. Punctures between the two LFC, and between LFC and lateral margin, large, round, shallow and separated by 0.5 to 1.0 times their diameters; above clypeus, on vertex, and on vertices of elevations strong, fine and dense. Labrum with setiferous puncture in lateral 0.25; shorter setae along front 0.5 separated by their lengths. *Pronotum* 0.6 times as long as wide. Lateral margins straight and subparallel to middle, then abruptly angulate, strongly convergent to front angles; lateral bead prominent, abruptly reflexed; front angles slightly obtuse, scarcely rounded. Disk 6-costate. PC 1 prominent and smoothly arcuate outwards; reaching from front 0.25 to hind margin; outer edge indistinct, not abrupt, surface smoothly continuous from vertex of PC 1 to lateral bead; inner edge very abrupt, deeply undercut and shining; surface between PC1 and PC 2 depressed, forming a broad trench. PC 2 straight and faint; reaching from front 0.25 to hind 0.25. PC 3 faint; weakly curved inward in front 0.1, then straight; reaching from front margin to hind 0.3. Punctures large, shallow and separated by approximately their diameters; round between median costae; elongate between PC 1 and PC 2 forming strigose pattern; less dense to lacking along lateral margin. *Elytron* wider at base than pronotum. Costae strong and even. SC attenuated in front 0.3. Vertices of costae with double row of fine setiferous punctures. Interspaces between costae with two fine, lateral carinae bordering a clear stria; strial punctures shallow, strongest at front margin. External subhumeral stria more coarsely punctate; area between it and lateral side coarsely punctate. Marginal stria indistinctly defined. *Propygidium* with PMC complete from front 0.2 to hind margin; indistinct in front; forming distinct tuberculate elevation behind. PLC indistinct. Punctures medium, round, shallow and separated by 1.0 to 1.5 times their diameters; punctures more distinct along their front edges. *Pygidium* with surface strongly convex. Front edge reflexed with distinct depression in front angles. Punctures similar to those on propygidium, but separated by 0.25 to 1.0 times their diameters; denser along hind margin. *Prosternum* strongly convex before procoxae, flat behind. Hind margin quite deeply, obtusely emarginate. Punctures medium, round, shallow and separated by their diameters; interspaces, hind margin and lateral margin behind procoxae with minute, round punctures. Prosternal lobe with small and minute punctures densest along midline, becoming sparser laterally. *Mesosternum* short and transverse. Front margin bisinuate; somewhat cuspid lobe fitting into prosternal emargination. Punctures medium, round, shallow and separated by 0.5 times their diameters. *Metasternum* separated from mesosternum by a clear suture. Median longitudinal suture fine. Punctures in front 0.3 and along hind margin large, round, shallow and separated by 0.5 times their diameters; becoming irregular and contiguous along lateral margin; interspaces and central areas with dense, minute punctures. *First abdominal* *sternum* covered throughout with punctures similar to those on front 0.3 of the metasternum. *Protibia* with nine spicules mounted on elevated bases.

MALES. Unknown.

SPECIMENS. UNITED STATES. COLORADO. Denver, X.1890, H. Soltau, 1 female, (USNM, Washington).

REMARKS. Although *soltaui* is very similar to *cynomysi* and *lecontei* there appear to be sufficient differences to retain it as a good species. Since *soltaui* is known from only two specimens the ultimate decision as to whether these differences are species differences, or merely represent extremes of a clinal variation, must be reserved until more material has been collected. S. Peck has kindly compared my specimen with the type. No significant differences were perceived.

11. *Onthophilus* *lecontei* Horn

Figures 17, 28, 48, 61, Map 4

Onthophilus *lecontei* Horn, 1870: 138. TYPE. Holotype, sex undetermined, bearing the following labels -- "Ca.", red "HOLOTYPE 3237", "*Onthophilus* *lecontei* Horn", type locality Fort Tejon, California, (MCZ, Cambridge).

DIAGNOSIS. *O*. *lecontei* is very similar in its general outline to *soltaui*, *wenzeli* and *cynomysi*. For characters that separate the last two from *lecontei* refer to the diagnoses for these two species. *O*. *lecontei* may be separated from *soltaui* by the characters given in the key. There are other comparative characters which separate these species. The lateral bead is not as robust in *soltaui*, the lateral margin is more strongly reflexed, PC 1 is more strongly undercut before the hind margin, the trench between PC 1 and PC 2 is deeper, and the sutural costa has an irregular double row of small punctures separating it from the suture. These punctures are less dense and often quite indistinct in *lecontei*.

MALES. Length: 2.5 to 3.0 mm; width: 1.9 to 2.1 mm. *Head* with VFC small, low tubercle. LFC attenuated before clypeus; the LFC convergent but not meeting. Surface between antennae to occipital carina depressed; clypeo-frontal surface elevated along midline. Punctures large, round and contiguous in frontal area and on genae; punctures much smaller on vertex and clypeo-frontal elevation. Labrum with setiferous punctures in lateral 0.25. *Pronotum* 0.5 times as long as wide. Lateral margin smoothly arcuate or with slight angles at midpoint; lateral bead very strong with inner depression deep and extending along front margin. Front margin smooth, deep, round emargination; front angles 90°. Disk 6-costate. PC 1 slightly curved outward; reaching from front 0.25 to hind margin; outer edge indistinct, not abrupt, surface continuous from vertex to lateral margin; inner edge abrupt, strongly undercut along its entire length; surface between PC 1 and PC 2 depressed, forming a shallow trench that reaches the front angles. PC 2 very weakly subsinuate; attenuated before hind and front margin. PC 3 straight; attenuated before hind margin; strongest at front margin. Punctures medium, round along lateral edge and between PC 2 and PC 3; more elongate in depression between PC 1 and PC 2 and between the two PC 3; punctures encroaching on PC 2 and PC 3 in hind 0.25. *Elytron* wider than pronotum. All costae equally well developed and entire. SC attenuated in front 0.2. All costae with a row of minute punctures on each side just below the vertex, that bear minute setae in the hind 0.3. Spaces between costae with a strong stria that is bordered on each side by a low carina; strial punctures oval and deep, with small tubercle on each side that interrupts the carinae; first puncture behind the front margin especially deep; punctures in the mid-section of stria one, two and three slightly deeper; minute punctures between costae and carinae. *Propygidium* with lateral margin angulate in front 0.2. PMC indistinct; reaching from front margin to hind 0.3; higher and broader in hind 0.5. Surface weakly depressed behind PMC. Punctures medium size, and elongate; interstices arranged in strigose pattern. *Pygidium* with no carinae; surface convex with transverse depression behind front margin. Punctures medium, round and separated by their diameters; becoming finer towards hind margin. *Prosternum* weakly depressed between procoxae, convex in front. Hind margin with obtuse, somewhat rounded, deep emargination. Punctures medium, round and separated by 1.0 to 2.0 times their diameters; much smaller punctures on interspaces. Prosternal lobe with small punctures; surface strigulate. *Mesosternum* short and transverse. Front margin lobed to fit prosternal emargination. Punctures similar to those on prosternum with at least two complete rows across. *Metasternum* separated from mesosternum by a fine suture. Median longitudinal suture very fine. Surface distinctly concave behind front margin. Large dish-like punctures with small deep punctures inside their leading edge, in front 0.5, along midline, along hind margin and on lateral areas; interspaces of large punctures and discal areas with minute punctures. *First abdominal sternum* with large punctures along front margin and on lateral areas; large semicircular median area punctulate. *Protibia* with six to eight strong spicules each on an elevated base. *Male genitalia* illustrated in fig. 17.

FEMALES. Length: 3.2 to 3.7 mm; width: 2.4 to 2.7 mm. The females differ from males very little except for sexual characters. They are on the average larger, the metasternum is not depressed and the protibial spicules are slightly stronger.

SPECIMENS. UNITED STATES. CALIFORNIA. Atascadero, 8.II. 1940, E.S. Ross, ex gopher burrow, 1 male, 1 female. Contra Costa Co., Danville, 5-8.XII.1951, F.X. Williams, ex *Vespula pennsylvanica* nest or debris, 1 male, 1 female; 9.II.1952, 28-30.III.1952, 17.IV.1952, F.X. Williams, ex gopher burrow, 15. Monterey Co., Carmel, 5.III.1914, 27. II.1915, 19.III.1915, 4.II.1917, S.L. Slevin, 4; Monterey, 20.XI.1925, S.L. Slevin, 1. Pasadena, XII, A. Fenyes Coll., 1 male, 1 female; II, A. Fenyes Coll., 1 female. Salada Beach, 21.IV.1928, F.E. Blaisdell, 1 male. San Diego Co., Poway, F.E. Blaisdell, 2. Santa Barbara, 22.XII. 1928, F.E. Blaisdell, 1 female. Santa Cruz, 21.V.1921, S.L. Slevin, on dandelion, 1 male. Tracy, 5.III.1939, 1 female. (Cal. Acad., San Francisco; Howden, Ottawa)

REMARKS. There is not very much variation expressed in the specimens of this species. The trench between PC 1 and PC 2 is less well developed and the lateral margin is weakly angulate in some specimens. These differences do not appear to be clinal, but are expressed irregularly throughout the known range. *O. lecontei* has been recorded only from the coastal areas of California, and is apparently well isolated today from other related species.

12. *Onthophilus thomomysi* new species

Figures 18, 29, 36, 49, 62, Map 4

Onthophilus thomomysi n. sp. TYPE. Holotype, male, MEXICO. Durango. 10 mi. W. El Salto, 4.VI.1964, H.F. Howden, ex *Thomomys* burrow, (CNC, Ottawa). Allotype, female, with the same data as holotype, (CNC, Ottawa). Paratypes, 11 males and 7 females with the same data as holotype, (CNC, Ottawa; Howden, Ottawa).

DIAGNOSIS. This species may be distinguished from the other species with equally well developed elytral costae, except *kirni*, by the absent or almost indistinguishable pronotal costae PC 2 and PC 3. For characters that separate thomomysi from kirni, refer to the diagnosis for the latter. Some specimens of *thomomysi* may be confused with very worn specimens of *lecontei* in which the pronotal costae PC 2 and PC 3 may be very low. These species may be separated by the pronotal punctures. The punctures of *thomomysi* are small, round and separated by several times their diameters. The punctures of *lecontei* are medium sized, oval and separated by their diameters.

MALES. Length: 3.2 to 3.4 mm; width: 2.6 to 2.7 mm. *Head* with VFC and LFC obsolete; indicated by broad, rounded elevations. Punctures on frons, vertex and above antennal sockets small, round and separated by several times their diameters; larger and sparser on genae. Labrum with setiferous punctures in lateral 0.25; surface densely punctulate. *Pronotum* 0.5 times as long as wide. Lateral margin weakly, broadly angulate; lateral bead prominent, with shallow inner groove, strongest in hind 0.5. Front margin deeply roundly emarginate; front angles 90 . Disk 2-costate. PC 1 strong, arcuate outward; reaching from front 0.25 to hind margin; outer edge smoothly continuous with surface between it and lateral margin; inner edge abrupt, strongly undercut and shining; surface mesad of PC 1 depressed, forming a shallow trench that runs the length of PC 1 and curves to the front angles. PC 2 and PC 3 entirely absent or sometimes faintly indicated by more shining and very weakly elevated areas. Punctures round, small on disk, larger along lateral margin, in lateral trench and along the hind margin; separated by two or more times their diameters. *Elytron* wider than pronotum. All costae equally well developed. SC attenuated in front 0.1. EC 3 slightly lower just behind front margin. All costae with two irregular rows of minute punctures, one on each side just below the vertex, that bear short setae in the hind 0.4. Spaces between costae with two low carinae and a strong, clear stria between them; strial punctures oval, deep and with small lateral tubercles that interrupt the carinae; strial punctures much stronger and deeper at the front margin, and slightly deeper in the midsection of stria one and stria two. *Propygidium* with lateral margin obtusely angulate in front 0.3. PMC and PLC faint, broad and low; more prominent in hind 0.6. Punctures along front margin small, round and separated by 2.0 to 5.0 times their diameters, gradually becoming smaller and sparser, almost absent from middle to hind margin. Pygidium with TC faint, broad, low and sinuate, its midpoint almost reaching front margin, its lateral ends in front 0.25. Punctures throughout small and round; separated by 2.0 to 4.0 times their diameters. *Prosternum* depressed between procoxae. Hind margin with deep, cuspid emargination. Punctures small, round and sparse; punctulate in front of hind margin. Prosternal lobe impunctate. *Mesosternum* short and transverse. Front margin lobed to fit prosternal emargination. Two transverse rows of small, round punctures separated by 2.0 times their diameters. *Metasternum* separated from mesosternum by a fine suture. Median longitudinal suture fine. Midline and large discal areas punctulate. Punctures in front and hind 0.3 small and round, separated by 2.0 to 4.0 times their diameters; punctures in lateral 0.5 large, shallow, somewhat irregular and dish-like, with small deep punctures within their front edges, confluent to separated by their diameters. Surface depressed behind front margin.

First abdominal sternum with punctures along front margin and on lateral areas similar to those along front margin of metasternum; large, semicircular central area that is punctulate. Protibia with eight spicules each on an elevated base. Male genitalia illustrated in fig. 18.

FEMALES. Length: 3.5 to 3.6 mm; width: 2.7 to 2.8 mm. The females are very similar to the males. The metasternum is not depressed and there are two rows of punctures similar to those along the front margin, along the longitudinal midline.

SPECIMENS. Type series. NEW MEXICO. Engle, 1 (MCZ, Cambridge).

REMARKS. Very little variability was noted, other than for the slight differences in the development of the pronotal costae. All specimens were heavily covered by a hard accretion of waxy exudate and adhered soil particles.

As with cynomysi, the name thomomysi does not intend to imply that this species is characteristic of, or confined to the burrows of Thomomys, but it is proposed merely to indicate the niche from which this species was first collected.

13. Onthophilus kirni Ross

Figures 19, 30, 50, 63, Map 1

Onthophilus kirni Ross, 1944b: 115. TYPE. Holotype and allotype, Texas, seven and one-half miles S.E. Somerset, 18.II.1943, A.J. Kirn, collected in a bait trap in a Geomys burrow, (Cal. Acad., San Francisco). Not seen. Paratypes, numerous males and females collected at the above locality in baited traps and by excavating Geomys burrows by A.J. Kirn and E.S. Ross, (deposited in numerous collections).

DIAGNOSIS: The males and females of this species can be readily distinguished from other species in which the elytral costae are equally well developed by the following combination of characters. The pronotal costae PC 2 and PC 3 are entirely obsolete. The third elytral costa is abbreviated in front by a short, deep, transverse trench that joins stria three and stria four. The metasternum is densely and finely punctate.

MALES. Length: 2.8 to 3.0 mm; width: 1.9 to 2.2 mm. Head with VFC and LFC poorly indicated by broad, low elevations. Punctures round, medium sized, slightly larger on frons and genae than on vertex, and separated by 0.5 to 1.0 times their diameters. Labrum with setiferous punctures along front margin; one long seta in lateral 0.25; other setae much shorter and separated by approximately their lengths. Pronotum 0.75 times as long as wide. Lateral margin very broadly, obtusely angulate, somewhat rounded; lateral bead prominent with a deep inner groove along the entire length of side, deepest at front angles. Front margin shallowly, roundly emarginate; front angles almost 90°. Disk with two broad trenches in lateral 0.25; trenches shallow, broader at their hind end, narrowing towards the front, reaching front 0.3; inner edge poorly indicated; outer edge equivalent to PC 1, abrupt, undercut, deepest at the hind margin, curved and shining. Punctures medium sized and separated by 0.5 to 1.0 times their diameters; round and densest between lateral margin and trench; elongate in trench and along longitudinal midline. Elytron with all costae approximately equally well developed, broad and low; EC 3 abbreviated before front margin by a short, deep, transverse fossa that joins stria three and stria four; EC 2 and EC 4 slightly broader and higher at front margin than other costae; SC slightly lower than other costae, separated from suture by a well defined, irregular row of small punctures; all costae with a double row of minute punctures that are indistinct in the front 0.5 and have minute yellow setae in the hind 0.3. Interspaces between costae with two lower carinae that border a clear stria; strial punctures not distinct except along front margin and in hind 0.3. *Propygidium* with front margin reflexed. PMC reaching from front margin to just before hind margin; tear-shaped, narrow and low in front, broader and higher behind. PLC low and indistinct. Punctures oval and medium sized, separated by 0.5 to 1.0 times their diameters; leading edge of punctures better defined than trailing edge; punctures finer and sparser on vertex of PMC. *Pygidium* as long as wide. Surface convex; front edge most abrupt, forming a broad, transverse channel just behind the front margin. Punctures round and the same size as those on the propygidium; deeper and larger in the transverse channel. *Prosternum* very slightly concave between procoxae. Hind margin roundly emarginate. Punctures similar to those on the head, but with minute yellow setae arising from them in the hind 0.5; punctures on prosternal lobe smaller. *Mesosternum* short and transverse. Front margin lobed to fit the prosternal emargination. Punctures similar to those on hind 0.5 of prosternum. *Metasternum* separated from mesosternum by a clearly defined suture. Median longitudinal suture strong and fine. Surface shallowly depressed behind front margin. Punctures on the central area like those on hind 0.5 of prosternum; larger and very irregular on lateral 0.25. *First abdominal sternum* punctate throughout with punctures similar to those on the central area of metasternum. *Protibia* with eight spicules, each on an elevated base. *Male genitalia* illustrated in fig. 19.

FEMALES. Length: 3.0 to 3.6 mm; width: 2.4 to 2.6 mm. The females are very similar to the males, except that the metasternum is not depressed, and the protibial denticules are larger, more numerous and extend almost to the base.

SPECIMENS. I have seen a series of forty paratypes from California Academy of Sciences, San Francisco.

REMARKS. E.S. Ross and A.J. Kirn encountered *kirni* in large numbers in the nesting chambers of *Geomys breviceps attwateri*. As many as nineteen were found in one nest. In total they collected 115 specimens by digging out burrows and by bait traps (Ross, 1944a, b).

14. *Onthophilus giganteus* new species

Figures 65, 66, 67, 68, Map 5

Onthophilus giganteus n. sp. TYPE. Holotype, male, FLORIDA. Alachua Co. 1 mi. W. Archer, 15-19.I.1976, J.R. Diley, ex malt trap (FDACS, Gainesville).

DIAGNOSIS. This species may be separated from all other species by the following combination of characters: size over 4 mm; very strongly broadened front ends of elytral costae EC 2 and EC 4; very large and deep strial punctures just behind the front margin of the elytra.

MALES. Length: 5.6 mm; width: 4.1 mm. *Head* with VFC well developed, reaching from occipital carina to frons between antennae. LFC present near antennal sockets, obsolete elsewhere. Punctures minute, deep, separated by several times their diameters; denser on vertex and above clypeus. Labrum with minute, dense punctures; setiferous punctures in lateral 0.25. *Pronotum* transverse, 0.5 times as long as wide. Lateral margin arcuate, very strongly reflexed; lateral bead prominent. Front margin broadly, roundly emarginate; reflexed from front angles to PC 2. Disk

6-costate. PC 1 long, strongly angulate in front 0.2; reaching from front 0.2 to hind margin. PC 2 sinuate, broader behind; reaching from front margin to just before hind margin. PC 3 weakly indicated by broad elevations, slightly curved outward; reaching from front margin to hind 0.2. Surface very convex, very deeply depressed between PC 1 and PC 2; depression broad behind, narrowing towards front margin. Punctures on disk small to minute intermixed, sparser on costae and along lateral margin, depression impunctate. *Elytron* wider than pronotum. EC 2 and EC 4 slightly higher, much more robust at front margin than ESC, ISC, EC 1, EC 3, EC 5 and SC. EC 3 interrupted before front margin by short, deep, transverse fossa between EC 2 and EC 4; SC attenuated in front 0.5. Strial punctures oval, deeper, more pronounced towards hind margin; stria two, three, four and five with extremely large, deep punctures just behind front margin. Punctures on vertices of costae minute, oval, sparse. *Propygidium* with PMC strong, tear-shaped; reaching from front 0.5 to hind margin. PLC as long as, and converging towards PMC behind. Punctures medium, round, deep, separated by 2 to 3 times their diameters; contiguous just behind front margin; punctures on vertices of elevations minute. *Pygidium* with LC obsolete in middle 0.3; strong in hind 0.3; low, bicarinate in front 0.3. TC indicated by broad, low elevations. Punctures similar to those on propygidium. *Prosternum* slightly depressed between procoxae. Hind margin broadly, roundly emarginate. Punctures similar to those on propygidium, denser along lateral margin and behind; interstices of large punctures and prosternal lobe punctulate. *Mesosternum* short, transverse. Front margin lobed to fit prosternal emargination. Punctures slightly larger than those on prosternum; contiguous or fused laterally. *Metasternum* separated from mesosternum by a fine, distinct suture. Median longitudinal suture fine, distinctly impressed. Surface with broad, median depression in front 0.3. Punctures along hind margin like those on mesosternum; laterally large, irregular, shallow, confluent; fused into broad, deep, punctate fossa along inner margin of lateral metasternal stria; punctures on disk and interstices of large punctures sparse and minute. *First abdominal sternum* with front margin reflexed. Punctures medium, deep, sparse behind front margin; forming short fossa behind metacoxae; large, shallow, irregular, contiguous laterally; minute elsewhere. *Protibia* with fourteen spicules, each on a weakly elevated base; apical three contiguous. *Male genitalia* illustrated in fig. 68.

FEMALES. Unknown.

SPECIMENS. This species is known only from the holotype.

REMARKS. *O. giganteus* is by far the largest species of *Onthophilus* yet described. It is nearly 1.5 mm longer than the next largest and nearly four times longer than the smallest. Apparently it belongs near *nodatus*, but the elytral costae are not as unequally developed.

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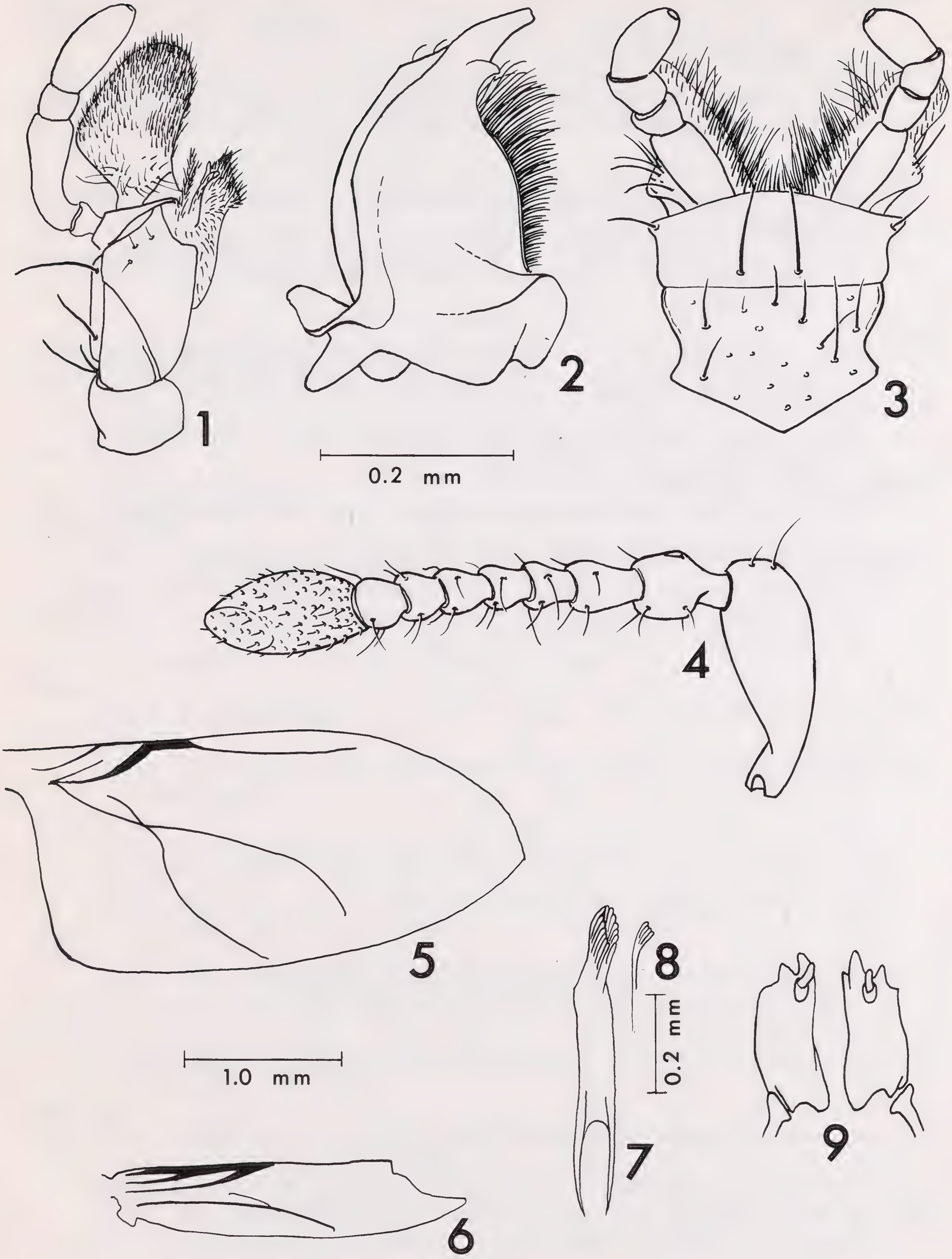
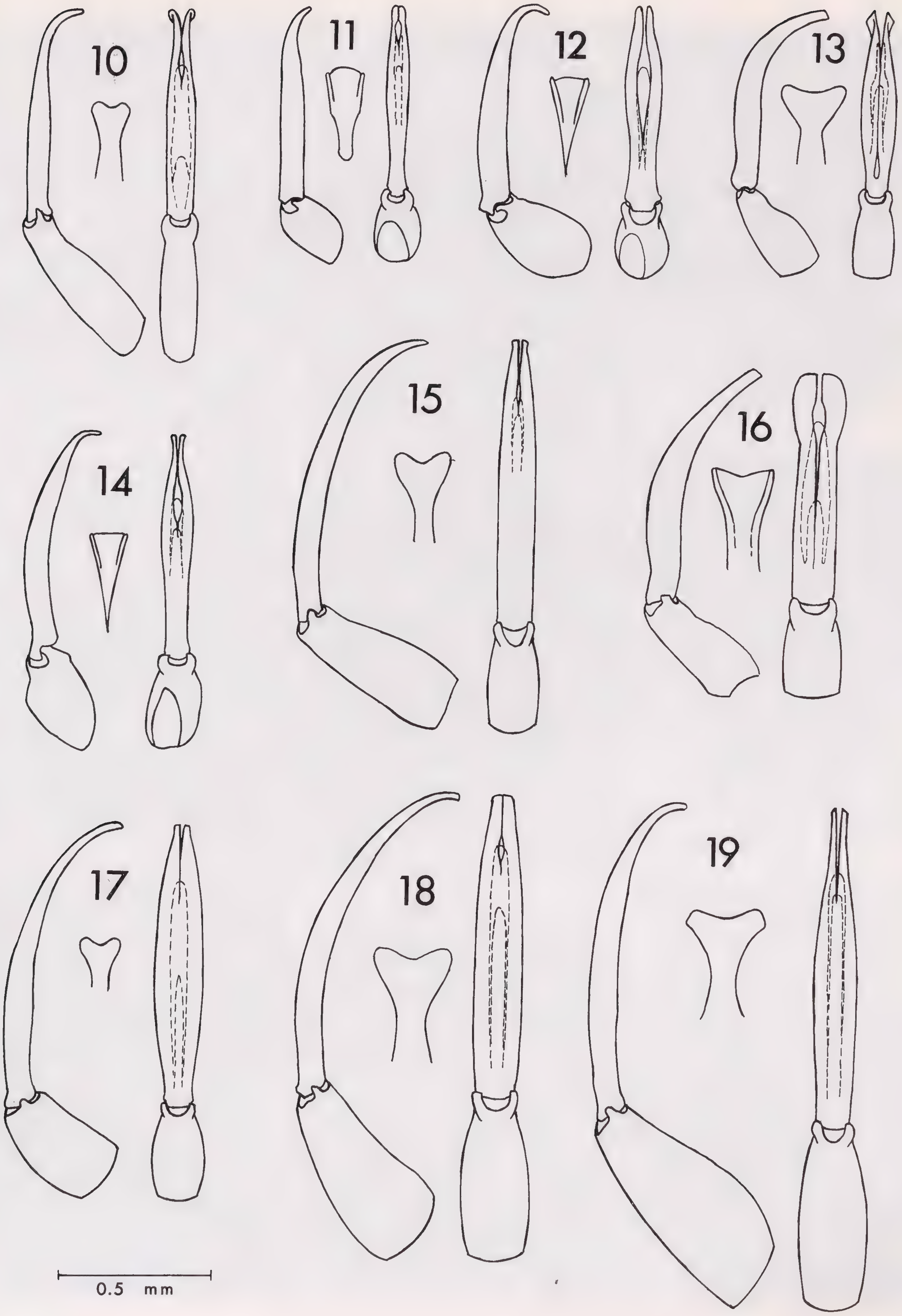
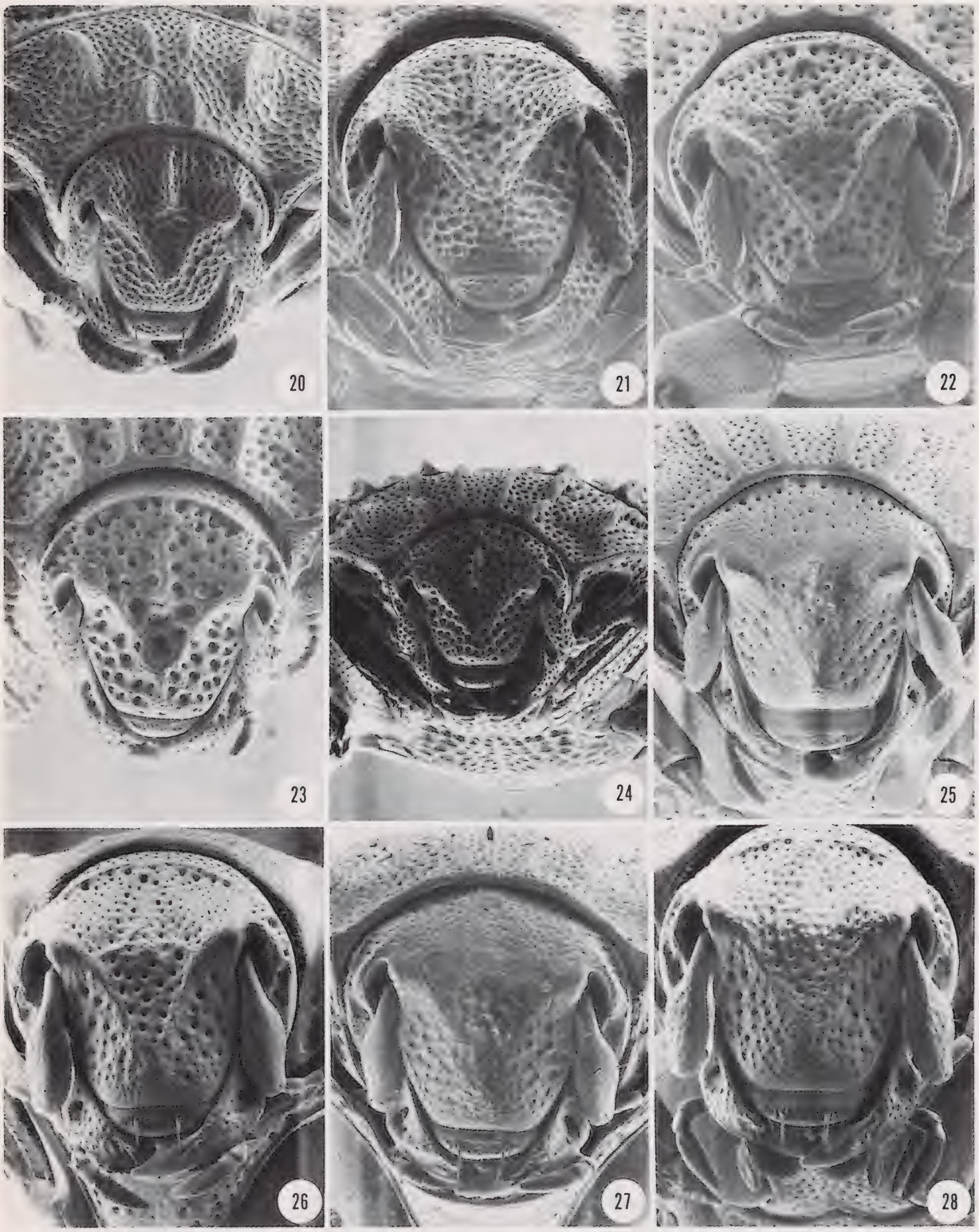


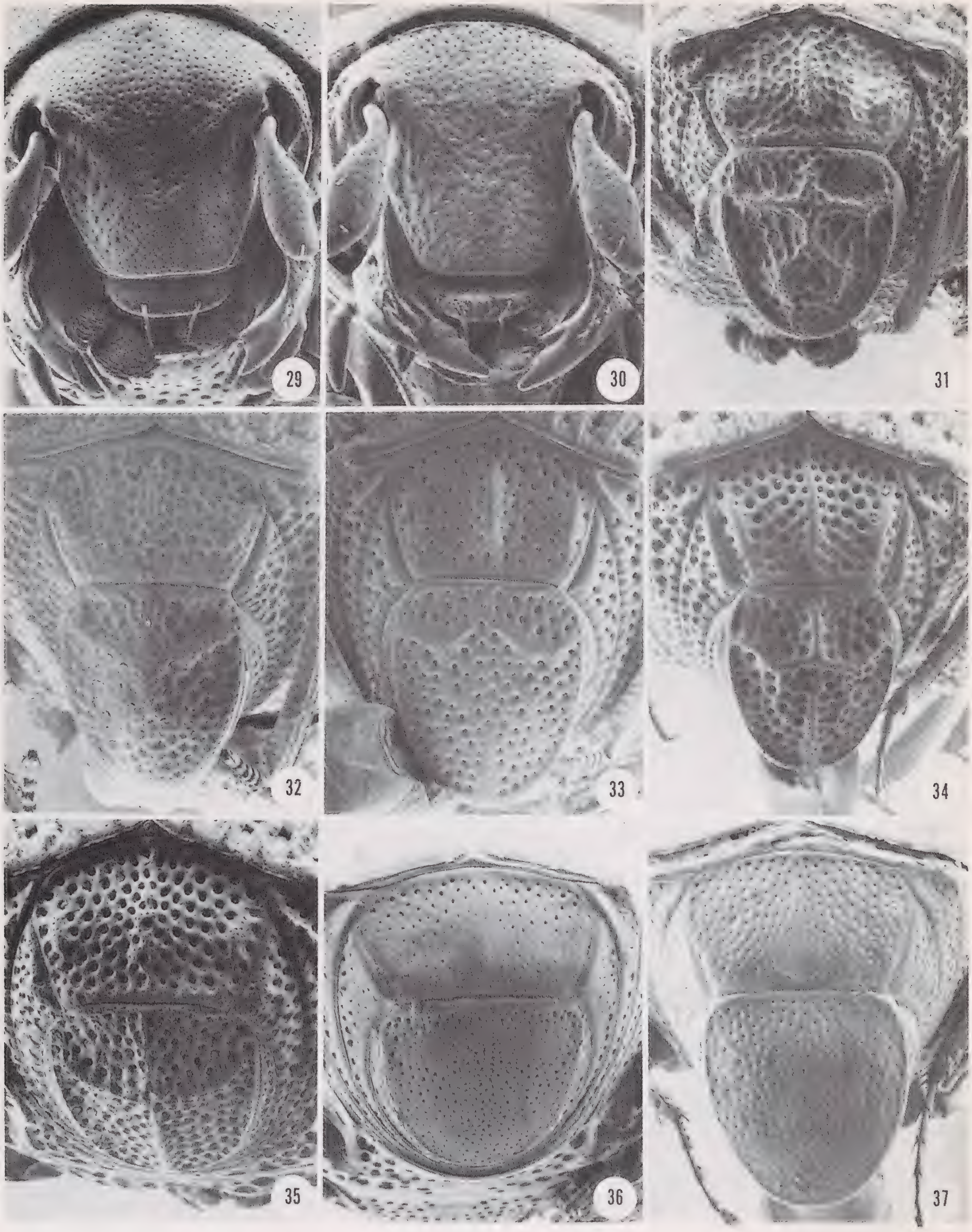
Figs. 1-9. *Onthophilus* spp. 1-5. *alternatus*, male. 1. anterior view of left maxilla; 2. anterior view of left mandible; 3. ventral view of labium; 4. antenna; 5. right hind wing; 6. *flohri*, female right hind wing; 7-8. *alternatus*, male. 7. penis; 8. median lobe of penis; 9. *flohri*, female styli of ovipositor.



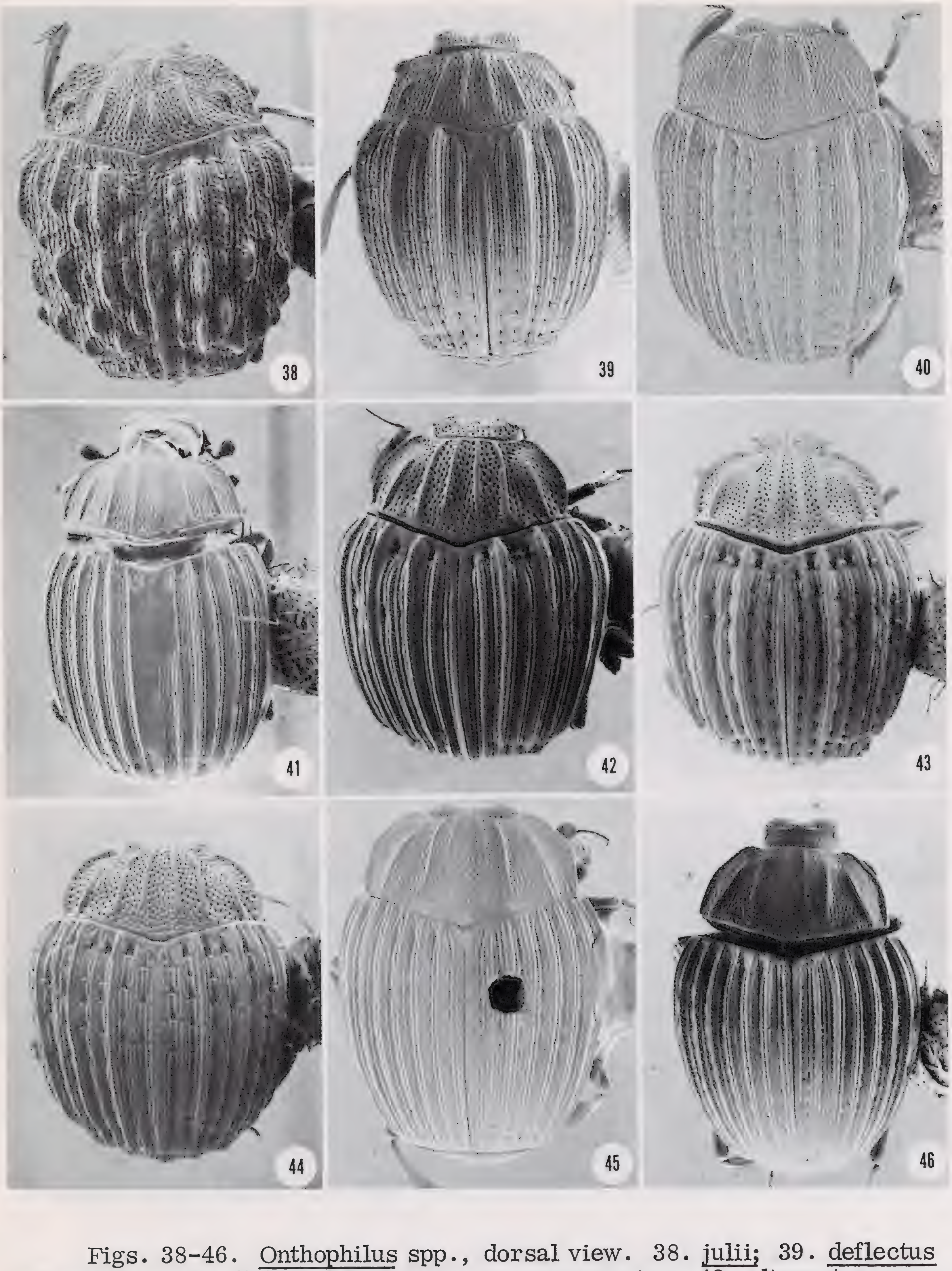
Figs. 10-19. *Onthophilus* spp. male genitalia (lateral view of aedeagus, ventral view of 9th sternite, dorsal view of aedeagus). 10. *alternatus*; 11. *deflectus* new species; 12. *flohri*; 13. *pluricostatus*; 14. *intermixtus* new species; 15. *cynomysi* new species; 16. *nodatus*; 17. *lecontei*; 18. *thomomysi* new species; 19. *kirni*.



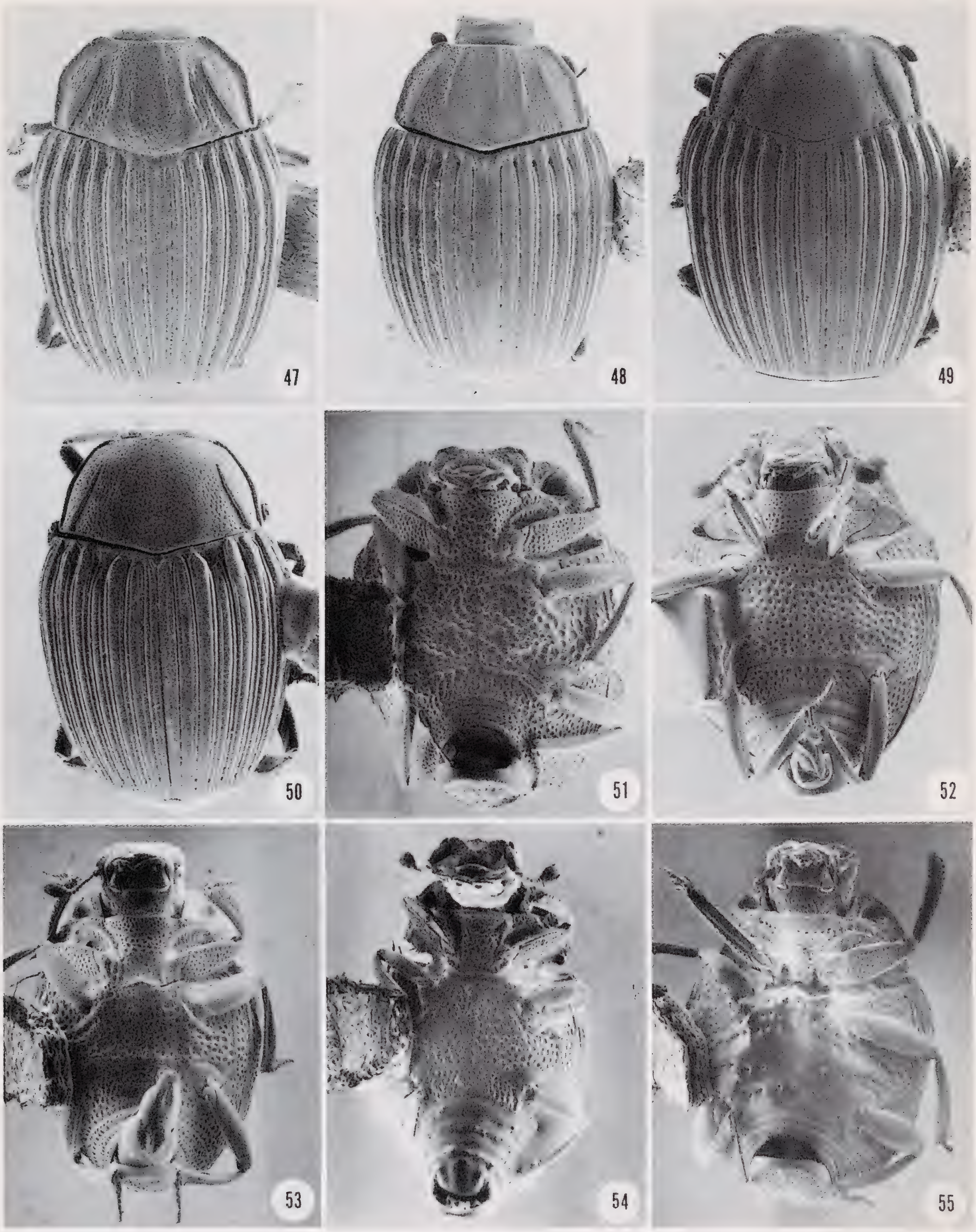
Figs. 20-28. Onthophilus spp., anterior view of head. 20. julii; 21. flohri; 22. alternatus; 23. nodatus; 24. pluricostatus; 25. wenzeli new species; 26. cynomysi new species; 27. soltaui; 28. lecontei.



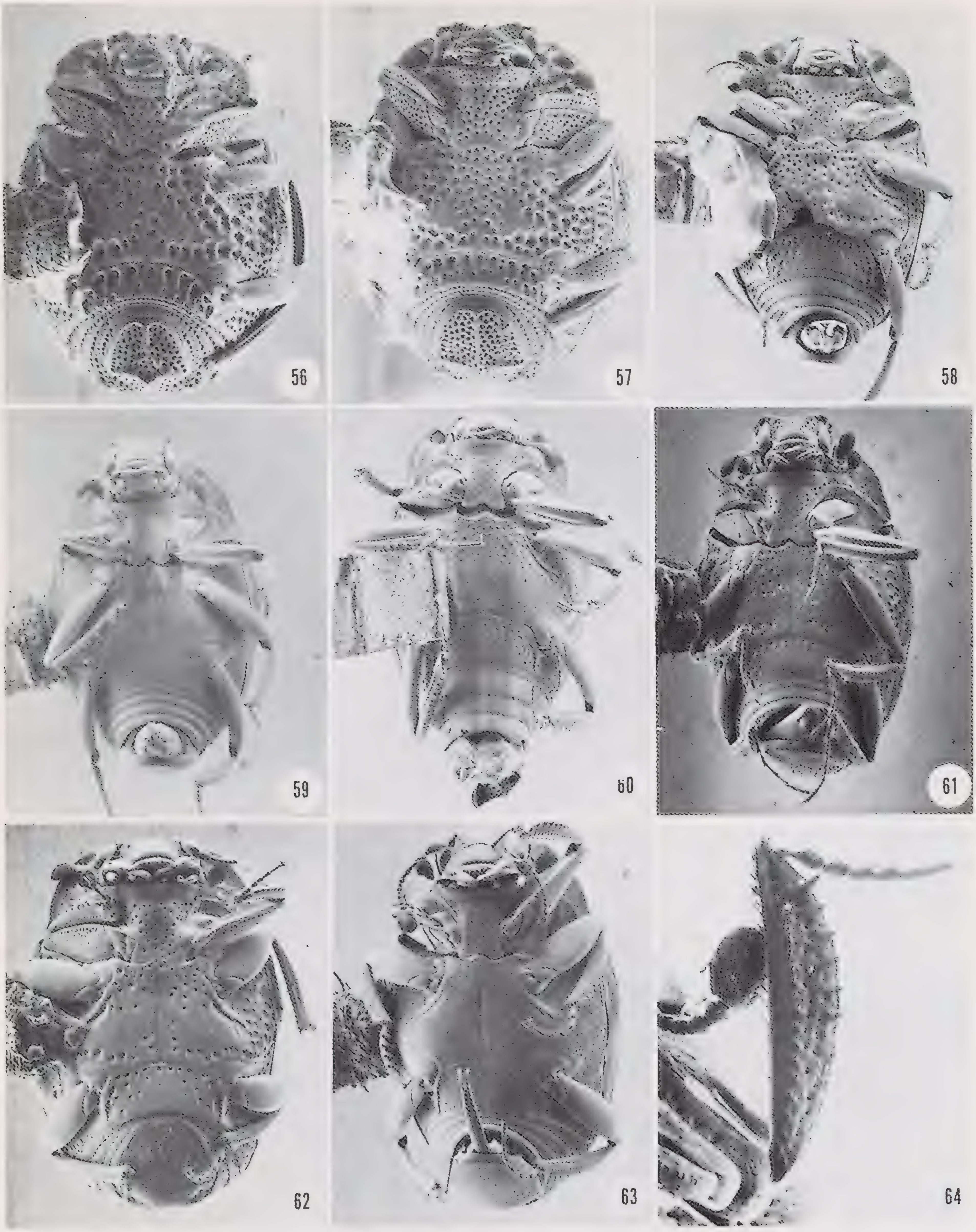
Figs. 29-37. *Onthophilus* spp. 29-30. anterior view of head. 29. *thomomysi* new species; 30. *kirni*. 31-37. posterior view of propygidium and pygidium. 31. *julii*; 32. *flohri*; 33. *alternatus*; 34. *nodatus*; 35. *pluricostatus*; 36. *thomomysi* new species; 37. *cynomysi* new species.



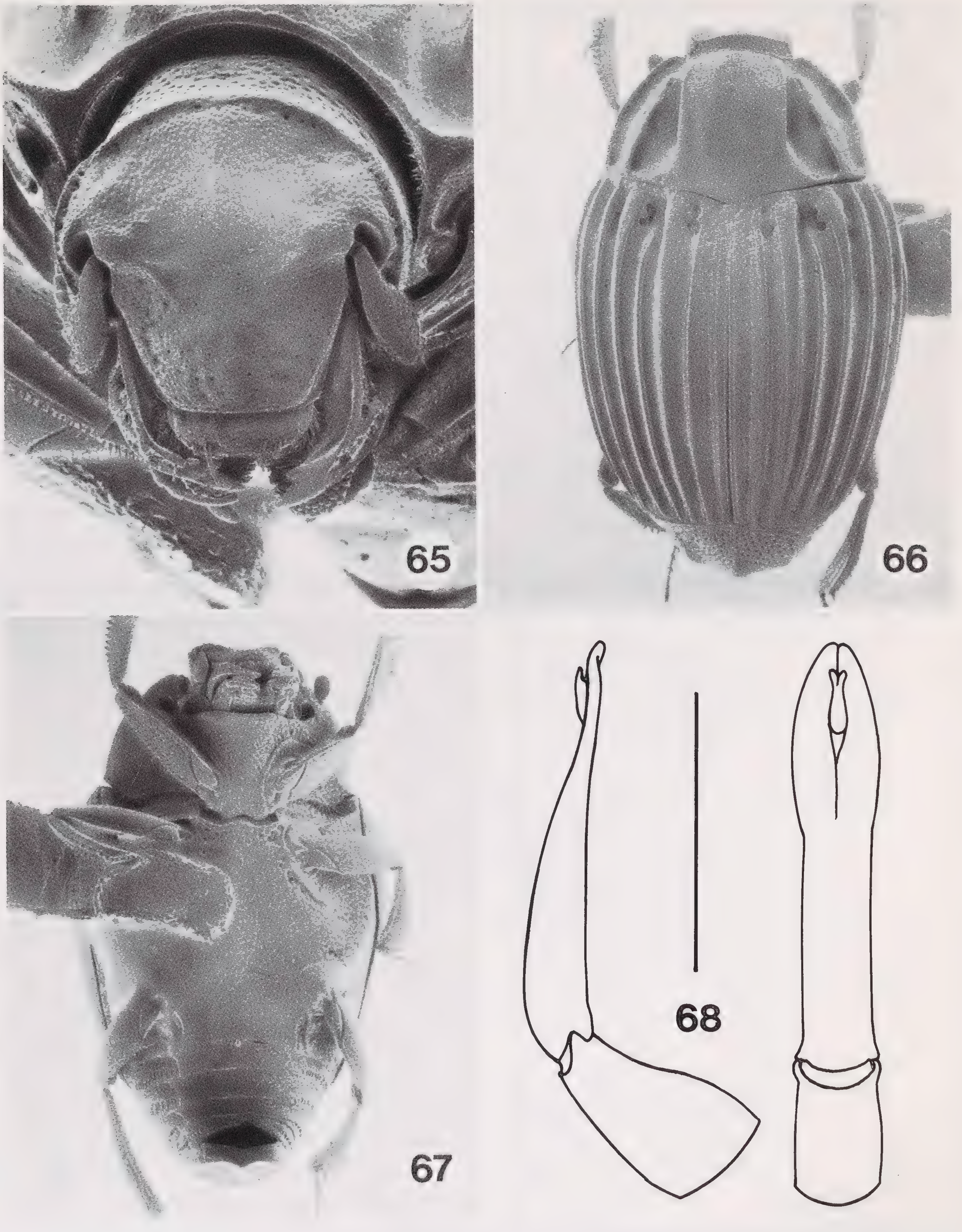
Figs. 38-46. *Onthophilus* spp., dorsal view. 38. *julii*; 39. *deflectus* new species; 40. *flohri*; 41. *intermixtus* new species; 42. *alternatus*; 43. *nodatus*; 44. *pluricostatus*; 45. *wenzeli* new species; 46. *cynomysi* new species.



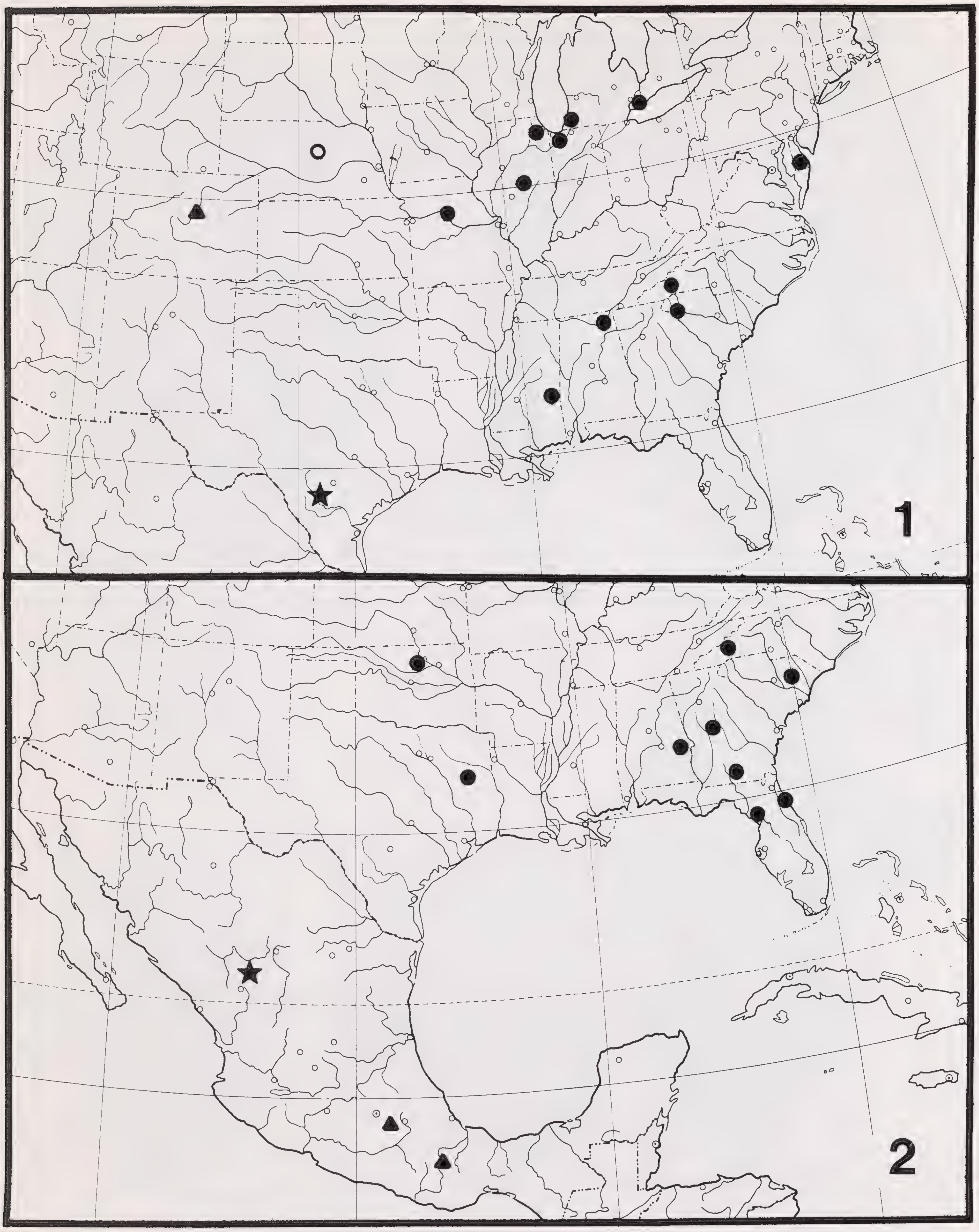
Figs. 47-55. *Onthophilus* spp. 47-50. dorsal view. 47. *soltaui*; 48. *lecontei*; 49. *thomomysi* new species; 50. *kirni*; 51-55. ventral view. 51. *julii*; 52. *deflectus* new species; 53. *flohri*; 54. *intermixtus* new species; 55. *alternatus*.



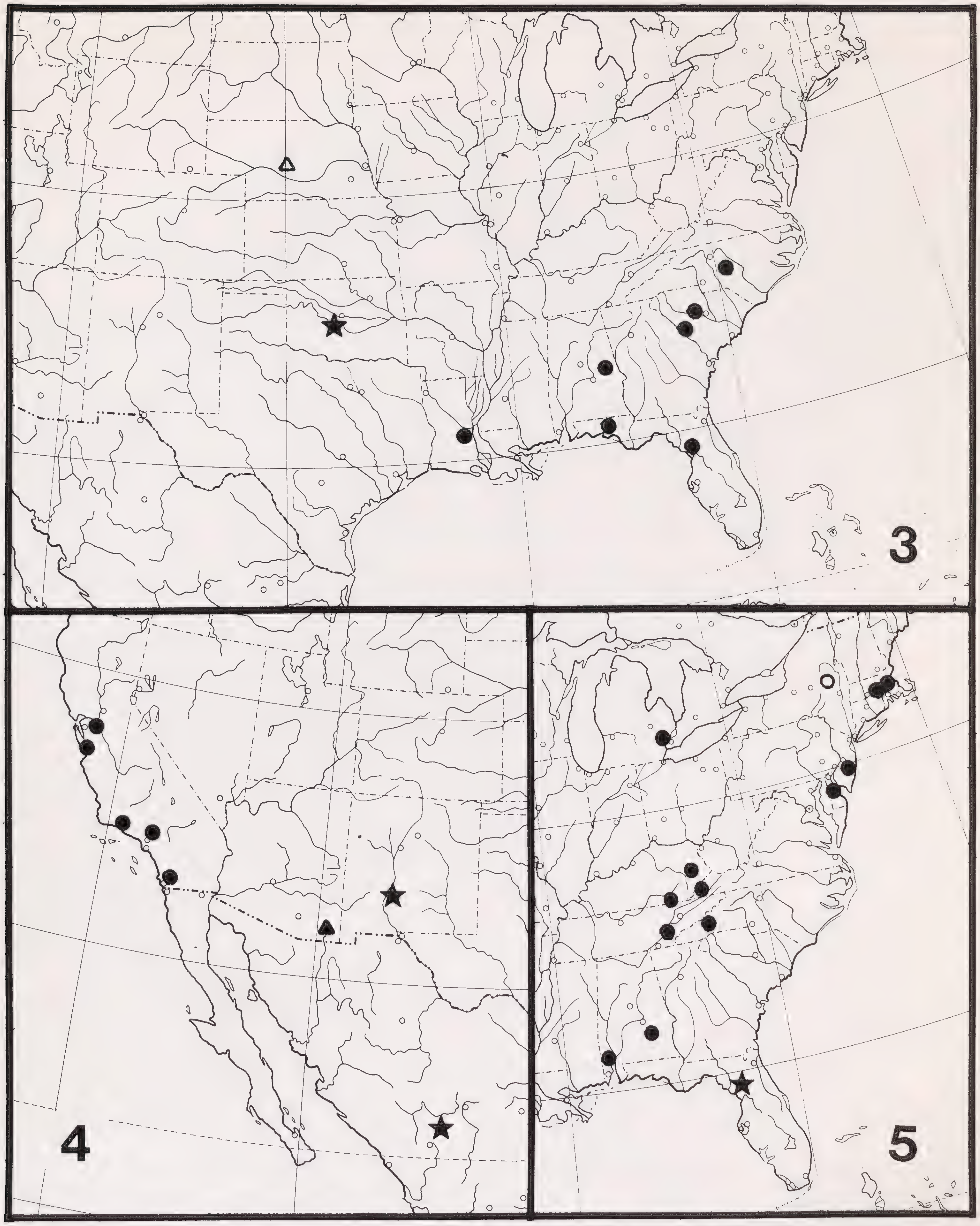
Figs. 56-64. *Onthophilus* spp. 56-63. ventral view. 56. *nodatus*; 57. *pluricostatus*; 58. *wenzeli* new species; 59. *cynomysi* new species; 60. *soltaui*; 61. *lecontei*; 62. *thomomysi* new species; 63. *kirni*; 64. *alternatus*, male protibia.



Figs. 65-68. Onthophilus giganteus new species. 65. anterior view of head; 66. dorsal view; 67. ventral view; 68. male genitalia (lateral view, dorsal view).



Map 1-2. Distribution of Onthophilus spp.: 1. deflectus new species (●) (○ - state record); soltaui (▲); kirni (★). 2. nodatus (●); julii (▲); flohri (★).



Map 3-5. Distribution of *Onthophilus* spp.: 3. *alternatus* (●); *wenzeli* new species (△ - state record); *cynomysi* new species (★). 4. *lecontei* (●); *intermixtus* new species (▲); *thomomysi* new species (★). 5. *pluricostatus* (●) (○ - state record); *giganteus* new species (★).